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ENERGY SECURITY: AN AMERICAN IMPERATIVE

HEARING

BEFORE THE

COMMITTEE ON HOMELAND SECURITY AND GOVERNMENTAL AFFAIRS UNITED STATES SENATE

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TUESDAY, JULY 22, 2008

U.S. SENATE,
COMMITTEE ON HOMELAND SECURITY
AND GOVERNMENTAL AFFAIRS,
Washington, DC.

The Committee met, pursuant to notice, at 9:35 a.m., in room SD–106, Dirksen Senate Office Building, Hon. Joseph I. Lieberman, Chairman of the Committee, presiding.

Present: Senators Lieberman, Carper, Collins, Voinovich, and Domenici.

OPENING STATEMENT OF CHAIRMAN LIEBERMAN

Chairman LIEBERMAN. The hearing will come to order. Thank you very much for being here. Good morning and welcome to this hearing, which is entitled "Energy Security: An American Imperative."

The high price of gasoline today is literally wounding American families, businesses, and farmers, and it is causing the American economy to stagger. It threatens to impose terrible hardship this winter on families in places like New England that rely heavily on home heating oil.

The near total dependence of our economy, the energy sector of it—and particularly the transportation sector—on oil is weakening our Nation's position in the world while enriching and strengthening a lot of countries in the rest of the world, many of them volatile and some of them just plain hostile to the United States of America.

For well over a generation, America's leaders have seen this growing dependence on foreign oil but essentially sat back and watched passively as trillions of dollars of our American, hard-earned wealth has been used to buy that oil and thereby go to countries abroad. And during that more than a generation, America's leaders have done little or nothing about that problem. Apparently, it took $4-a-gallon gasoline to wake up the American people and their leaders here in Washington, to make all of us angry and anxious enough to get serious about breaking our national dependency on foreign oil.

And at this moment of crisis and opportunity in America, T. Boone Pickens comes on to the national stage with a classically American message of honesty, determination, and can-do optimism. He said some things in that advertisement on television that I think are going to be long remembered and that have aroused a lot

of Americans, who, like him, are sick of talk and want some action. I, for one, as a Senator who has been here for a while, have been very pleased with what T. Boone Pickens has done. And he is not just talk. He has offered us a plan—the Pickens Plan—which has been described, accurately, I believe, as a sweeping and innovative action program to loosen the grip that oil has on America.

The Pickens Plan has attracted attention, in part, because the author of the strategy to cut our reliance on oil is himself a legendary oil man. It has also attracted attention because T. Boone Pickens has invested a large amount of his own money to educate the public about the crisis and his proposed response to it. But, most important, I think, the plan has attracted attention because it is bold.

I am very pleased to have Mr. Pickens here as a witness today. Frankly, I am pleased because I hope his boldness will infect a lot of other people here in Washington with the power to do something about it so that we will be motivated to come together, forget our political differences, and do what is right for our country by getting something big done to break our dependence on foreign oil.

We have taken incremental steps over the years, and I have supported them. But the fact is they are woefully inadequate to the crisis that America faces. I, for one, am spoiling for some bold T. Boone Pickens-type action, and I know I am not alone.

We have a second panel that will testify today—three witnesses who, like Mr. Pickens, are well positioned to recommend strong steps that can enhance U.S. energy security and lift an economic burden from American families, farmers, and businesses.

Immediately after this hearing, Senator Collins and I are going to join Senators Brownback and Salazar in taking one such bipartisan step. We are going to introduce a bill called the Open Fuel Standard Act. One of our witnesses, Dr. Luft, has helped craft that bill, and I would not be surprised if he discusses it this morning. For me, this morning's hearing provides an important opportunity to listen, learn, and then, together, act.

Senator Collins.

OPENING STATEMENT OF SENATOR COLLINS

Senator COLLINS. Thank you, Mr. Chairman.

First, let me thank you for holding this hearing this morning. You and I have worked on a lot of important issues together, and I believe that our undertaking this hearing is one of the most important, for the fact is that our Nation faces an energy crisis.

The soaring price of oil is causing great harm to our economy, from the major industries that move our Nation to the small businesses that are the backbone of our communities. As I travel throughout Maine, I hear time and again of the hardship the skyrocketing cost of gasoline and home heating oil is causing families.

Although it is still summer, Mainers are deeply worried about how they will stay warm this winter. One woman told me that every month, half of her Social Security check goes to meeting the budget plan for her home heating oil. She is literally choosing between keeping warm and eating well, a choice that no American should ever have to make.

Beyond the impact on countless families struggling with high costs, our growing dependence on foreign oil is a threat to our national and economic security. One of our witnesses, Mr. Pickens, has vividly illustrated our ever-increasing dependence on foreign sources of oil in the Middle East and Venezuela. We are impoverishing ourselves while enriching regimes that are in many cases hostile to America. Ending our dependence on foreign oil and securing our own energy future is an American imperative.

Our Nation must embrace a comprehensive strategy to reduce, and ultimately eliminate, our reliance on Middle East oil. We must expand and diversify American energy resources, and while doing so, improve our environment.

To understand how we can meet the challenge of energy security, we can look back a half-century ago to another time when our Nation faced a great test. On October 4, 1957, America was in shock. We were stunned by an object the size of a beach ball, weighing just 184 pounds. That object was the Soviet satellite called "Sputnik."

We responded not by giving up, but with our own satellite launches and later an energetic commitment to land a man on the Moon. A strong partnership of government, research institutions, universities, and the private sector formed to support a bold new initiative in scientific advancement. And, as a result, in 1969, an American flag flew on the Moon.

The most remarkable aspect of that story is not that America met a challenge by developing superior technology, but that we embarked on that journey confident that the American spirit and know-how would triumph.

By contrast, our Nation missed an enormous opportunity on another October day 35 years ago. On October 17, 1973, the Organization of Arab Petroleum Exporting Countries, the predecessor of the Organization of Petroleum Exporting Countries (OPEC), hit the United States with an oil embargo.

The immediate results were soaring gasoline prices, fuel shortages, lines at filling stations, and an economic recession.

Unfortunately, after the immediate crisis passed, the long-term result was a steady increase in oil imports and a dependence that worsens each day. The 1973 embargo was a wake-up call that we failed to heed. The current crisis is a fire alarm that we must not ignore.

Meeting this challenge requires the skills and commitment that we see in our line-up of witnesses today—the entrepreneurial spirit of the private sector, an understanding of the specific economic and environmental issues at stake, and a commitment to the research and development of new technologies in all regions of our country.

It also requires action by government. From establishing a timeline for energy security to undertaking critical investments to stimulate research in alternatives to expanding the production and conservation tax credits, government has a critical role to play.

Above all, we must follow through. Let me give my colleagues one example of the lack of resolve that has been all too common for all too long.

The easternmost city in the United States is Eastport, Maine. Visit this pretty little city, and you will find the remnants of a tidal

power project initiated in the 1930s by President Franklin Roosevelt, who grew up observing the incredible tidal range there from his family's summer home on Campobello Island, across the bay in New Brunswick. Causeways to impound the water to turn the generators were built, as was housing for thousands of construction workers. Then, after just 2 years of preliminary work, Congress pulled the plug and canceled the project.

Why? Because Congress decided that it would be cheaper and easier to rely on conventional, fossil fuel generation closer to the population centers of southern New England. The challenges of building a transmission system to connect this rural region of Maine to the cities were deemed not worth the effort. Federal and State authorities failed to cooperate. The project was abandoned.

The technology of generators to tap tidal power has advanced greatly since the 1930s. Regrettably, the need for government to be more farsighted has not.

I have called for American energy independence by the year 2020, the same 12-year time frame that elapsed between Sputnik and Apollo 11. Some experts believe that such a goal is too ambitious, but I know that no goal is ever reached without first being set. Just as the America of a half-century ago boldly stated its intentions to reach the moon, we must now declare our intention to achieve energy independence and energy security.

Today, we will hear four proposals for improving America's energy security. I welcome Mr. Pickens to his first appearance on Capitol Hill since he unveiled his comprehensive plan to bolster America's energy security. Dr. Luft and Mr. Anderson will discuss transportation and community planning. And I am particularly pleased to welcome an engineering professor with whom I have worked closely, Dr. Habib Dagher of the University of Maine. I know that the Committee will be very interested in his presentation on harnessing the power of winds offshore and geothermal energy underground. Our witnesses will provide invaluable perspective on how we can progress toward a goal that is truly the new American imperative.

Thank you, Mr. Chairman.

Chairman LIEBERMAN. Thank you, Senator Collins, for that excellent statement and, if I may say so, for your own bold plan and proposal.

Mr. Pickens, thanks very much for being here. Thanks for this extraordinary act of leadership, I would say patriotism. The Committee looks forward to hearing your testimony now.

TESTIMONY OF T. BOONE PICKENS,[1] FOUNDER AND CHIEF EXECUTIVE OFFICER, BP CAPITAL MANAGEMENT

Mr. PICKENS. Chairman Lieberman, Ranking Member Collins, and Members of the Committee, thank you for having me here today. We are more fragile today from a national security standpoint than we have been since World War II. The danger stems from our overwhelming $700 billion dependency on foreign oil annually.

[1] The prepared statement of Mr. Pickens appears in the Appendix on page 41.

In 1945, we were exporting oil to our allies. By 1970, we were importing 24 percent of our oil. By the 1980s, it was 37 percent. And in 1991, during the Gulf War, it was 42 percent. Today, we are approaching 70 percent.

Much of our dependency is on oil from countries that are not friendly, and some would even like to see us fail as a democracy and as the leader of the free world. I am convinced we are paying for both sides of the Iraq war. We are giving them tools to accomplish their mission without ever having to do anything but sell us oil.

This is more than a disturbing trend line. It is a recipe for national disaster. It has gone on for 40 years now. This is a crisis that cannot be left to the next generation to solve, and it is a shame if we do not do something about it. And we can, without bringing our economy and way of life to a halt.

I have been traveling the country with a simple message. Our country is in a deep hole, and it is time to stop digging. I have a plan to do just that. The response from the American people has been overwhelmingly positive, and I have talked to a lot of people.

The Pickens Plan starts with harnessing wind and building solar capabilities. We are blessed with some of the best wind and solar resources in the world. The Department of Energy estimates that we can produce 22 percent of our country's electrical energy needs just by utilizing the wind resources in the Great Plains. And, actually, if you wanted to go beyond 22 percent, you could go to 40, 60, 80, whatever you want. That resource is unlimited. The plan substitutes electricity generated by natural gas-fired plants with wind-generated electricity. Natural gas-fired is 22 percent; the wind is going to replace that 22 percent.

The natural gas freed up is directed to transportation needs of the country. The natural gas is cheaper, cleaner than gasoline, and its supply is plentiful. And, most of all, it is American.

The Deutsche Bank today released a 50-page report,[1] which is called "From Shale to Shining Shale." What they are telling us is that there is a huge amount of shale gas available to us in the United States. Don't confuse this with the oil shale that is on the western slope of the Rocky Mountains. It is not the same geological situation.

The result would be a reduction of our dependency on imported oil by 38 percent. This plan is based on proven, existing technologies. It is simple, and it is doable. It provides a significant bridge—"bridge" underlined—to the future that gives us time to develop the next generation of alternative fuels, including electric or hydrogen vehicles. It results in revitalizing much of rural America; $1 trillion of private investment would go into the Great Plains of this country. Instead of enriching other nations, we would actually recover our rural areas. It can be accomplished with private investment, but it cannot be achieved unless our national government clears the way for action.

Government should move immediately to build the east-west transmission corridor to ensure wind power gets to market. This would include transmission rights-of-way. I envision this could be

[1] The Deutsche Bank report referenced by Mr. Pickens appears in the Appendix on page 125.

like in the Eisenhower Administration when they declared an emergency and built the interstate highway system. The way I recall it—and I have been around for a long time, so I should be able to recall it—there was an emergency because of the Cold War, and it was a way to move, if we had to move rapidly, our military.

But I also feel that this is an emergency, too, and believe maybe that could be the approach as it has to be done quickly because we are pressed by not only the 70 percent we are dependent on foreign oil, but the $700 billion a year that we are pouring out. And I am convinced that $700 billion is a minimum number because I think the price of oil is going to go up. I would project out for 10 years it is going to cost us—if we continue on the same route that we are on now, we will have bought $10 trillion worth of oil from foreign producers. Government must extend for at least 10 years the production tax credits (PTCs). The cost pales in comparison to the cost of foreign oil.

Let me quickly address what I call the five Pickens principles that should be used to assess any of the energy plans brought before you.

First, the plan has to slash our dependence on foreign oil by at least 30 percent in 10 years.

Second, the plan needs to rely on 100 percent North American resources.

Third, the plan needs to utilize existing and proven alternatives to foreign oil.

Fourth, the plan needs to call on private enterprise to execute quickly.

Finally, the plan requires the Federal Government to clear the path for implementation.

We have walked into a trap, and we have got to get out of it. We are the ones that put ourselves there. Nobody else. I am not pointing the finger at anybody. It is not going to help. But we have to work together and solve this national security crisis together. Thank you.

Chairman LIEBERMAN. Thank you, sir. That was an excellent beginning.

We will do 6-minute rounds so we can get as many Senators involved as possible.

Focus in, if you will, on exactly what you would like to see the Federal Government do to play its part in the implementation of the Pickens Plan. In other words, what are the kinds of tax credits, for instance, that you would like to see us adopt?

Mr. PICKENS. OK, let me identify—I will answer all questions. You know that. But I would like to comment that our problem and the reason why we have not done the things that we should have done to protect ourselves is because of cheap oil. And we sat here and really said, "Send us the oil. Never mind the price."

Chairman LIEBERMAN. Right.

Mr. PICKENS. Then the price went vertical, and when it did, everybody said, "I can't stand it. I didn't know I was signing up for this."

And so here we are, and we can expect that price to remain vertical. It will maybe plateau and go again, but I promise you, the people that have the oil are going to get the best price they can

for it. I do not care what they say. I do not believe them. I do not believe when they say we want to stabilize prices. When Russia, the largest producer with Saudi Arabia, both about 9 million barrels a day, are having meetings to stabilize the price, I do not think that is what they are talking about.

Chairman LIEBERMAN. I think you are right.

Mr. PICKENS. And here we are, we are the odd man out in the deal.

The PTCs for 200,000 megawatts of power, the PTCs for that would be $15 billion a year, and that would start it moving. Now, I know you are struggling with the PTCs now, and it expires in December, and you extend it one year at a time. To stabilize the opportunity, to cause the money to come into it, you should give a 10-year extension of the PTCs. But when you look at $700 billion going out of the country every year for the purchase of oil, a $15 billion PTCs is somewhat insignificant.

Chairman LIEBERMAN. Right.

Mr. PICKENS. I am not saying throw money away. You know that. But the $700 billion is so overpowering. But, anyway, 10 years with the PTCs——

Chairman LIEBERMAN. Would you change it at all from the way it is structured now to incentivize, for instance, wind and solar?

Mr. PICKENS. I am sorry. I cannot answer that. I am not that familiar with what the——

Chairman LIEBERMAN. Good enough. So you are saying lock in the production tax credit for a 10-year period so people can count on it.

Mr. PICKENS. Yes.

Chairman LIEBERMAN. And be prepared to put in $15 billion into that a year.

Mr. PICKENS. Right. And what will happen, I believe—and I have heard this, too, from some of the manufacturing companies that would like to be involved in developing some of this. They say if we could have PTCs for 10 years, we can move into the area, and we can develop this.

Now, let me give you an example. I am doing the largest wind farm in the world at Pampa, Texas. It is 4,000 megawatts. That is about the equivalent of two and a half nuclear plants. We will have manufacturing there. We had an economic study, and it would create 1,500 jobs for that area. And it amounts to $380 million a year in economic benefit to that.

And you can just see, I mean, the model town for this is Sweetwater, Texas. The town's population was 12,000, and it went below 10,000. Now it is above 12,000. Over 20 percent of the jobs there are related to wind energy. And you can see, I mean, it is a model that—it is not something that we studied and believed would happen. We know it will happen.

Chairman LIEBERMAN. In other words, it is real.

Mr. PICKENS. It is real.

Chairman LIEBERMAN. Some people are still coming around to the point that they think wind energy, and even solar, is a little bit flaky or a vision. But I have never associated the word "flaky" with you, now that I think about it. [Laughter.]

But we know it works.

Mr. PICKENS. We know it works. And, if you look at the most wind energy per size of country, it is Germany. And Germany does not even have good wind. We have fabulous wind. I would like to ask you to look at the map on the right.[1]

Chairman LIEBERMAN. Yes. We have copies of that up here.

Mr. PICKENS. Yes, you have it in front of you there.

Chairman LIEBERMAN. Yes, we do.

Mr. PICKENS. But that is a fabulous resource for this country, and you have it all along the coast, too. I mean, that is available if the people want it.

Now, I do not want it mandated that we have to develop for wind. I am telling you, the people in that central part of the United States call me. I have leased 300,000 acres to put wind turbines on.

The other day we were in Sweetwater, Texas, and we were with an ABC crew. And the ABC people were asking questions, and they said to one of the locals there in Sweetwater, "Are people unhappy with the development of the wind turbines?" He said, "No. The only people here that are unhappy are the ones that don't have the turbines."

Chairman LIEBERMAN. Got it.

Mr. PICKENS. They want them because it is income to them, and they need the income.

Chairman LIEBERMAN. Last week, former Vice President Gore made a proposal, another bold plan, which is to try to get America to produce within 10 years 100 percent of its electricity from renewables. Is that doable, do you think?

Mr. PICKENS. I do not know. Mr. Gore and I talked the other day—his concern is global warming.

Chairman LIEBERMAN. Right.

Mr. PICKENS. And global warming for me is page 2. Page 1 for me is national security because of the 70 percent that we are importing. And also the $700 billion that is flowing out of the country. And I told Mr. Gore, I said, "Al, I will get to page 2 after I clean up page 1." So mine is a different approach. And he said, "Well, you are for outer continental shelf (OCS) drilling." I said, "I am for everything that is American. Everything." Am I opposed to the electric car? Absolutely not. Plug-in electric, let's do it.

Chairman LIEBERMAN. Flex fuel? Anything that works.

Mr. PICKENS. Anything that is American. I only have one enemy, and that is foreign oil. That is what I want to get rid of. And if you look at it, my plan will reduce our dependency on foreign oil by 38 percent. And it was not designed this way. It just happened to be. It is a coincidence, maybe. But we have plenty of natural gas to do what we need to do, and if we could use natural gas for transportation fuel as a bridge fuel to hydrogen, electric, or whatever, by 2050 we have to be off of hydrocarbons. We will still have hydrocarbons in the country, I hope, but that will not be our primary transportation fuel. But if you look at our imports, 38 percent of our imports come from the Mideast and Africa, the two most unstable areas.

Chairman LIEBERMAN. Interesting.

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[1] The posters referenced by Mr. Pickens appear in the Appendix on page 53.

Mr. PICKENS. We can replace 38 percent of the transportation fuel with natural gas.

Chairman LIEBERMAN. Excellent. My time is up. Thank you. Senator Collins.

Senator COLLINS. Thank you.

Mr. Pickens, your plan focuses on land-based windmills in the Midwest, and it has the advantage of helping to supply the electricity needs of a lot of the populated areas of the Midwest. I am obviously not from the Midwest. I am from New England, which has a huge reliance on natural gas for electricity. It is about double the national average, and that is something that I agree we need to change.

What do you think that we should do in the Northeast, and New England in particular, to help reduce our reliance on imported oil? Eighty percent of the households in my State of Maine use heating oil, so this is truly a crisis in our State. Do you have any suggestions for broadening your plan to help the coastal areas of our country?

Mr. PICKENS. I will use a broad brush sometimes, OK? And if it is too much, well, pin me down. But heating oil—that is foreign. Assume it is foreign because we are importing almost 70 percent. Some of it may come domestic, but, anyway, that is foreign. Get that over to natural gas, is what we should do, and the Northeast should get off of heating oil.

As far as your using natural gas for power generation, don't worry about it. Keep doing it. What will happen is the power generation, the natural gas will move out of that sector as it moves into transportation fuel. So we do not have to shut down all of our natural gas power generation. It will just happen naturally. But what we have to do is we have to mandate the use. For instance, all government vehicles purchased in the future would be natural gas. That will send a message to General Motors, Ford, Chrysler, and all the others—I never recognize any manufacturers in the United States except those. Pardon me for that, but that comes with age. I just know three car manufacturers. I say that and I own a Honda GX natural gas car because I cannot get an American natural gas car.

But GM makes 19 vehicles in the world today for natural gas. None are made in the United States. They are made in South America and Europe. So I know they know how to make them. So if the government mandated that all vehicles at some point would go to natural gas on new cars, they would get them. They would make them, and it would be a revitalization of the auto manufacturers in the United States. And God knows they need it, too. They need the help. They need all of it.

This has great economic benefits for rural America, car manufacturers, and all kinds of different areas that we could help our economy with it. But it will happen if the leadership will say let's do this. Then let it unfold, and it will take place. Private industry will build the grid if you will give private industry the corridors that they can build in. That is what you have to do for us.

And if the government wants to build the grid, that is good, too. But I think we should start to look at the future for energy for America, and that is that we have a national grid, that we can put

this together and get the foreign oil dependency out of the way. We can do it. We have not been tasked, the American people have not been tasked to do what has to be done.

For instance, people told me at breakfast this morning, "Well, wind is only 40 percent of the time." That is OK. Use the 40 percent. Baseload it with something, peak it with something. I am not an authority on power generation. That is not my field. I am a geologist. I know about the oil business. But I do know that we have not been charged with the responsibility to do it. Go do it, and everybody in this country will join together. The people will follow if we have the leadership, that's what it takes. And you are going to have to tell them that—explain to them first. They don't know. I promise you, the American people do not understand what we are up against. I know that from polling. I know it because I have been in the field; I have talked to people; I have looked at the focus groups. I have done everything. I think I am prepared to respond, and I know I would have never committed the $58 million to telling this story had I not felt like the people did not understand.

I will tell you what they do understand. They know it is something very bad about energy. They do not think they are being told the truth about energy. And it is confusing to them. I think when we come out of this, by the time we get—I want to elevate this into the presidential debate, and it is not there yet. OK. Elevate it there. By the time we get the elections over, whoever wins, the American people are going to demand they know the truth about energy, they know what they are up against, and they will respond.

We will see the energy use go down dramatically when they see what it is going to cost. They can see that it does not have anything to do with Exxon or Chevron or anybody else running up the price. It does not have anything to do with some speculator on Wall Street. That is not what we are faced with. We are faced with 85 million barrels a day of production in the world, and we are using 25 percent of it, with 4 percent of the population, and we only have 3 percent of the reserves. In the United States, we have nothing to do with the price of oil. We only have 3 percent of the reserves.

And so you tell me that a guy in China is buying a barrel of oil for $140 that he thinks it is somebody's fault in the United States. He does not think that. He understands. They know what it is. It is a global price for oil. You look at Brent crude, sold on the London exchange every day, and it is very close to West Texas Intermediate (WTI) crude.

So, anyway, I have drifted off the question, but I really do get somewhat carried away with this subject.

Senator COLLINS. Just a quick follow-up, if I may, Mr. Chairman.

Chairman LIEBERMAN. Go ahead.

Senator COLLINS. When we look at your map, in addition to the wind corridor up through the Midwest, from Texas to the Canadian border, the other areas that have a lot of wind are offshore, for example, offshore of Maine's coast, the Great Lakes region. Do you see potential in offshore wind to also be part of the answer?

Mr. PICKENS. Sure. I see everything American is good—offshore wind, central part of the country wind, electric car. Everything American is good. I am for that. Offshore, OCS drilling, Arctic Na-

tional Wildlife Rescue (ANWR) drilling, yes, all of it. I want to see all of it. I want to get off of foreign oil. Yes, all that.

If I could put up the map of the world there, and you have that in front of you, I believe.

Senator COLLINS. Yes.

Chairman LIEBERMAN. Yes, we do.

Mr. PICKENS. But here, if you will notice, the United States has the best wind energy in the world. Now, you can see some areas over in Europe and around different places, but on landmass alone, we have the best wind energy. And we are going to use it. There is no question we are going to use it. And it can be melded with baseload peak and wind. Solar comes into play. Solar and wind work very well together. But we have not been pushed against—we are against the wall now, but we have not been charged with getting ourselves straightened out in America. And the reason is because the oil is so cheap. That is it. We sat around and just kind of lazied it, and here we are.

Senator COLLINS. Thank you.

Chairman LIEBERMAN. Thank you, Senator Collins. Senator Voinovich.

OPENING STATEMENT OF SENATOR VOINOVICH

Senator VOINOVICH. Thank you, Mr. Chairman.

What you have had to say is music to my ear. I have been on this Committee now 10 years, and we have had an environmental policy—you are talking about cheap oil, but we have had an environmental policy around here that ignores our national security, our economy, our energy needs, and the chickens have come home to roost. And now we are trying to figure out how we are going to get out from under this.

Many of us feel that we ought to go after every drop of oil that is available to us, can be taken out environmentally. Many of us also believe that we need to have an Apollo type program as we did—President Kennedy said we were going to put a man on the moon in 10 years, and by golly, we did. There is no reason why we cannot figure out how we can get off of our appetite for oil.

But one of the things that I never gave any consideration to, Mr. Pickens, was natural gas, and the reason—I have looked at renewables, plug-ins, hybrids, you name it. But I did not look at natural gas for the simple reason that the cost of the natural gas in this country has skyrocketed to the point where in my city of Cleveland, Ohio, my State, we were paying about $3 a Mcf back in 2000; now we are paying about $10 a Mcf, and the people in the gas association here in Washington say we may go up to $14 or $15 a Mcf. And part of the reason why, as you know, we went to natural gas is we made it easy for energy companies to use natural gas because it was cleaner and did not have as much emissions as, say, coal or something else.

So I would like you to respond to the issue of how can we do this when natural gas has skyrocketed, and I think you probably know that in 1998 and 1999, we were exporting about $19 billion worth of chemicals. Today, we are a net exporter, and the reason why is because natural gas is a feedstock of the chemical industry, urea. So that is one question.

The other one is the issue of wind in that currently wind produces about 1.5 percent of our energy in this country. I think renewables are about—let's see, about 9 percent, most of it is hydroelectric. How can you ramp that up over a quick period of time? And, second of all, as you know, down in Texas you have had some times when the wind just kind of stopped and you have had some reliability problems. And if you are going to use wind, you know that if you are going to have reliability, you are going to have to back up that wind with some ordinary baseload energy generation.

So those two questions. How do we do this with the high cost of natural gas as it is? And, second of all, the whole issue of the reliability of wind in terms of a baseload provider of energy in this country.

Mr. PICKENS. Senator, on the expense of it, one Mcf of natural gas equals 8 gallons of gasoline in energy. OK. They will do the same job, one Mcf and 8 gallons. Today, natural gas is selling for $12 per Mcf. If you had 8 gallons of gasoline at $4, it would be $32. So natural gas is the cheapest of the fuels now. Natural gas is selling at 40 percent of heating oil. In the winter, heating oil and natural gas trade at parity. In the summer, not so, and we are in the summer now. So natural gas—I almost hate to tell you this—is cheap compared to the other fuels. When you look at oil at $140 per barrel, natural gas, at $12 or $15 per Mcf, is cheap.

Senator VOINOVICH. Where do we get the natural gas? In other words, what we have done in a way is we have increased the demand for natural gas, but the supply of natural gas is down and, therefore, the price is up. And how do you reconcile that in terms of what you are talking about?

Mr. PICKENS. Supply is up. We are up year over year. We have increased the reserves of natural gas in the United States. We have doubled them in 5 years.

Senator VOINOVICH. How come, then, we are going to be paying $15 an Mcf in Ohio for natural gas? And I think around the country they are predicting—they are coming to Congress right now and asking for more Low Income Home Energy Assistance Program (LIHEAP) money because of the fact that the natural gas costs are going to be skyrocketing.

Mr. PICKENS. It is because your energy costs are higher, is what it is. I mean, it is not a case that somebody is gouging you. Natural gas is selling at 40 percent of the cost of heating oil. Heating oil, you can call it foreign. So you are being—I mean, it is all swinging off of the price of oil, is where you are coming from. And when natural gas gets cheap enough that it will do a job that coal—I mean, it can compete with coal at times, it will get that cheap. It did a year ago. We were down to $6. Now it is up to $12. If not, it is $10. But it has been up to $12 this summer.

But you are dealing with a market. I am going to send you this report that came out today on how we have developed in this country. In 5 years, we have doubled our gas reserves. This is huge. And as a geologist, if you had told me this would have happened 10 years ago, I would have not given you one chance in 10,000.

Senator DOMENICI. What is it you have, Mr. Pickens? What is it you are going to give us?

Mr. PICKENS. Oh, I am going to send you this report from Deutschebank today. It is called "From Shale to Shining Shale."

Senator DOMENICI. OK.

Mr. PICKENS. It is about the technology and how much gas has been discovered in the United States and how much we can have in the future. But this is nothing more than a bridge to the next fuel because when you get to 2050, we are pretty well maxed out on hydrocarbons as a transportation fuel. And 70 percent of the oil is used for transportation. When a barrel of oil comes to the United States today, it will be moved to a refinery, refined, then go into marketing, then go into our cars, and in 4 months it is gone. It is gone. We burn it up. It is out of here. And so we have to get a hold of this situation and realize that we cannot control—one thing, though, that I will say, we have plenty of natural gas to do what I am talking about, and we can do it for 20 or 30 years.

Senator VOINOVICH. If the price is way up and it seems that the supply must not be up, as much up in terms of the demand, you are telling us that we have the natural gas available, we just have to go after it. Is that what you are saying?

Mr. PICKENS. Sure. We have to develop the natural——

Senator VOINOVICH. And you can't do this program without going after more natural gas in this country?

Mr. PICKENS. But don't get the idea that you are going to have natural gas cheap. All energy is more expensive. The cheapest that you are going to find is wind and solar. The rest of them are going to be expensive.

Chairman LIEBERMAN. Thanks, Senator Voinovich.

Senator Domenici, welcome. I know that Mr. Pickens knows, but Senator Domenici was the long-time chair of the Energy Committee and is now the Ranking Member. We are glad to have you here this morning.

OPENING STATEMENT OF SENATOR DOMENICI

Senator DOMENICI. Thank you. Mr. Chairman, he knows me from a lot longer ago than you know me.

Mr. PICKENS. Senator Domenici and I have had business for 40 years.

Senator DOMENICI. And I am most amazed to see him at his age take this new business venture, and I am very pleased with the expertise that you are applying to it.

I want to suggest a couple of things. You are so right that we must get the people to understand; that the United States is sending so much of our resources to foreign countries just to acquire crude oil; that it should be doubtful in the minds of intelligent people as to whether America can continue this kind of exportation of our assets, of our resources to foreign countries for 5 or 10 years. I actually do not believe we can. I believe we will become poorer and poorer and poorer as we send $500 to $700 billion a year overseas for crude oil. We are in a real mess.

Some people tell me what you are for, and they confuse me, and so I want to ask you so we will get it here on the record. We have a bill coming up on the floor of the U.S. Senate that is supposed to create an energy debate. Even though it is the end of the year,

we are supposed to have some time to discuss some of our energy woes and do something positive about them.

You are not against us opening more of the offshore assets of the United States where there are 85 percent that are locked up in a moratorium of one type or another and you cannot drill even if you wanted to. Are you on the side of those who say lift those and start drilling in an appropriate——

Mr. PICKENS. I am saying do everything you can do to get off of foreign oil, is what I am saying.

Senator DOMENICI. And that is one.

Mr. PICKENS. That is one. It is not going to do it.

Senator DOMENICI. Oh, no. Of course not.

Mr. PICKENS. It is not big enough. You do not have enough reserves in the offshore to do it. It will just be a piece of our problem.

Senator DOMENICI. Right.

Mr. PICKENS. And that is it.

Senator DOMENICI. From the standpoint of the United States and paying what we are paying for oil, if we can get a reserve that is anywhere from 14 to 30 billion barrels, that is a pretty good addition to the world availability of oil that we are going to be committing to the pool if we take off those moratoria and say it is available.

Mr. PICKENS. If you did 13 billion, added 13 billion, you would add another Prudhoe Bay. Prudhoe Bay was the largest field ever found in the United States. If you added 13 billion, you would add—our reserves today are about 20 billion. So you would have 60 percent more than what we have now.

Senator DOMENICI. It is commonly understood that without even using modern techniques for evaluating the asset value resource—because we have not applied modern techniques. We have not wanted to spend money, if you would believe it, to do a seismic evaluation of these assets because for 27 years we have locked them up with moratoria. That is a nice way to treat an American asset for 27 years, lock it up and then say we do not know what it is worth because we have not inventoried it.

Mr. PICKENS. Let's look at what we are talking about in the east and west coast, not ANWR.

Senator DOMENICI. Yes.

Mr. PICKENS. The U.S. Geological Survey (USGS), I think, says you have 85 billion barrels. Now, know that is an in-place figure. That is not a recoverable all figure.

Senator DOMENICI. Correct.

Mr. PICKENS. When they talk about the 90 billion off the coast of Brazil, that is an in-place figure again, not a recoverable. And I have seen some that have compared those two, that the Brazilians have 90 billion barrels, and we have about the same. Their 90 billion is not a proven number, and it is thrown around pretty loosely. But go to the facts and the biggest basin that we have where we have recovered the most oil in America is the Gulf of Mexico. So look at South Louisiana, Gulf of Mexico, and what have you recovered there? You have recovered 40 billion barrels, and it is by far the preferred place to look for oil instead of off the west coast or the east cost of the United States.

Senator DOMENICI. Twenty-five percent of America's oil comes from just where you said.

Mr. PICKENS. That is right. And so it is—I am not a big believer—I think you are going to get a rude awakening as to value of the east and west coast when it is opened up and when it is put up for sale. When those tracts are put up for sale, I think you are going to be surprised at the price you get for the tracts.

Senator DOMENICI. We will see. But, in any event, it is certainly worth it for the United States, for our people to understand that this is an asset of theirs and we ought to see what we have got and see how we can use it. And I just want to make sure that——

Mr. PICKENS. I agree.

Senator DOMENICI [continuing]. You said that was so.

Let me talk a minute with you about turbines that run the wind generation. I understand that the United States does not manufacture these turbines. Is that correct?

Mr. PICKENS. No. I bought them from GE, $2 billion worth of them, to do a thousand megawatts on our first step of our 4,000-megawatt project. And they are manufactured in the United States by General Electric.

Senator DOMENICI. It is generally understood by those of us who have been briefed that most of the turbine production is in Germany, not in the United States. Now, maybe GE produces——

Mr. PICKENS. Well, Siemens is in Germany and Vesta is in the Netherlands, and Mitsubishi is in the game, too. But we can get all that business into the United States.

Senator DOMENICI. That is the point.

Mr. PICKENS. Yes. We can get it all here.

Senator DOMENICI. If, in fact, we are on a stable path of multiple-year use, we can get them to move here.

Mr. PICKENS. If they know that we are committed to doing it, is where we are coming from.

Senator DOMENICI. It seems to me it is kind of strange that all of a sudden we have come back to natural gas in cars. About 10 years ago, we were pretty much hitting hard on let's get gas in fleets, let's have police fleets, let's have bus fleets. And then we sort of let it all pale off. And now there is a big push to get natural gas automobiles. Am I correct?

Mr. PICKENS. Yes, you are. And, actually, it was further back than 10 years ago. I was in Albuquerque, and because of the air quality there, they were interested in natural gas to replace gasoline and diesel. That was about 15 years ago.

Senator DOMENICI. All right.

Mr. PICKENS. And Las Vegas has the same problem. And, of course, Los Angeles does. But if you look at the largest bus fleet in the world today, it is in Beijing—all natural gas. I was there in July of last year, and they have over 4,000 buses. The second largest bus fleet is Los Angeles MTA. And when you look at the Port of Los Angeles, which is switching over now from 22,000 18-wheelers, it is switching over to natural gas. And I think the first tranche was 8,000 18-wheelers there.

But look at what happened last week, Senator. Gazprom announced they are building natural gas fueling stations all over Europe.

Senator DOMENICI. Yes.

Mr. PICKENS. They are switching over, too. But here we are, we still drift. There are 8 million natural gas vehicles in the world today—8 million—and that has gone from 5 to 8 million in 2 years.

Senator DOMENICI. And where are we?

Mr. PICKENS. One hundred and forty-two thousand.

Senator DOMENICI. Right.

Mr. PICKENS. Out of 8 million. We have done absolutely nothing.

Senator DOMENICI. Well, we are not promoting it. We have not yet decided that—your testimony here today, where you say there is an abundance of natural gas, we as a Nation have not yet decided that is true because we have had such pressure from the chemical industry and others that use it as feedstock to make it available to them so they can keep jobs here, that we have not focused on automobile engines to be fed by natural gas.

I believe we are on the track right now, with electric automobiles, if we could add a bigger incentive for natural gas cars and trucks—if we could get that going, it seems to me that we would have taken a giant stride in the right direction toward minimizing our use of crude oil from overseas because automobiles and transportation drive our dependence.

Mr. PICKENS. If you take 22 percent of our power generation and make it with wind and take the 22 percent of natural gas that is doing power generation to transportation fuel, you will reduce our dependency by 38 percent. And what you will do is you will bring down the price of gasoline. I promise you that you will do that. And we will do it with our own fuel. It will not be some other—now, one thing—and Senator Voinovich mentioned that he is concerned about the price of natural gas.

Senator DOMENICI. Yes.

Mr. PICKENS. But what happens is that we are not protecting the chemical industry with cheap anything. It is not our job to provide it cheap to the chemical industry. I mean, they are going to have to compete globally. Well, you think natural gas is cheap in Europe? Natural gas is $18. If you want a load of liquified natural gas (LNG) spot on the market day, you will pay $18 for it. And so we are in a global market, and the price of energy can be graded every day all around the world.

Senator DOMENICI. Well, the report that you are going to give us on natural gas is coupled with some new reports that are saying that we have new finds of natural gas that you did not even dream of when you were a gas man. They are all over the country, and it is shale gas, and it is 5,000 to 6,000 feet deep, and it is in States like Ohio, States where we never did develop any natural gas, we are developing it. But that has not reached us yet in terms of information.

Mr. PICKENS. Let me say that the largest gas field in the United States, believe it or not—I can see it out the window of my office. If somebody had told me in the Fort Worth basin that Barnett shale would become the largest gas field in America, I would have bet you $100,000 to a cup of coffee and figured I would start drinking the coffee right away. [Laughter.]

But what you have is the largest gas field, and that happened in 5 years. Now, the Hainesville, which is in northern Louisiana

and East Texas, the Hainesville is five to six times the size of the Barnett. And then you have the Marcellus in Appalachia, and it is twice as large as the Barnett. And, you go to Fayetteville, you go to Woodford, you go to these different shale basins, there are 21 of them now, and the technology was developed by us—not me, but America. We did it here. We developed the technology to extract natural gas in large quantities. But on the price of that, though the cost to develop that, you are talking about $7 an Mcf. Everything is more expensive, is what it is. The big frac jobs go into that, but we have that resource here.

I almost think it is divine intervention to have the gas show up at such a critical time for this country, and to be able to use it as a bridge to the next fuel in the next 20 or 30 years.

Chairman LIEBERMAN. Thanks, Senator Domenici.

Senator DOMENICI. Thank you, Mr. Chairman.

Chairman LIEBERMAN. How do you take your coffee? [Laughter.]

We will do a second round of 6 minutes.

I want to come to the price effect here. You mentioned it briefly in response to one of Senator Domenici's questions, and I understand if we implemented the Pickens Plan and we moved to wind and solar and natural gas, moved over and took over part of the transportation sector, that we would achieve for America and for our economy a significant reduction in the transfer of our wealth abroad. That is a major accomplishment.

But let me come back to the consumer side of it because in a way, what has finally, as I said in my opening statement, sounded the alarm, Paul Revere-like, for the American people and even their leaders in Washington is that the price of gasoline has gone over $4 a gallon. I know it is hard to say this with any certainty, but if the Pickens Plan were implemented totally, in 10 years what do you imagine the effect—I am not asking you for an exact penny prediction here, but what would be the effect on the price of both electricity and energy to power our transportation sector? Do you think it would, generally speaking, go down a little, a lot, go up, stay the same?

Mr. PICKENS. We are 10 years out now?

Chairman LIEBERMAN. Yes.

Mr. PICKENS. There is no question that if I am right on the peak oil at 85 million barrels, in 10 years we are going to have less than 85 million barrels available to the world. Now, the question is: What is the demand?

Chairman LIEBERMAN. Right.

Mr. PICKENS. I have to think in 10 years the demand for oil—because the price now is going up. In 10 years, you are going to have $300 a barrel oil. Maybe higher, I don't know. But this is really—it is a tough question to look out 10 years on this one. But I can tell you this: In 10 years, if we continue to drift like we are drifting, you are going to be importing 80 percent of your oil. And I promise you, it will be over $300 a barrel.

Chairman LIEBERMAN. I am just imagining the movement on the commodity exchanges right now in response to what you just said.

Mr. PICKENS. Imagine the pain that you are going to——

Chairman LIEBERMAN. Yes, but I presume that what you are saying is, if we adopted your plan, the prices, generally speaking, for

the consumer of electricity and transportation would be less than they would be if we do nothing.

Mr. PICKENS. They would be less if we do nothing?

Chairman LIEBERMAN. Than if we do nothing.

Mr. PICKENS. If we do nothing——

Chairman LIEBERMAN. Go with the status quo.

Mr. PICKENS [continuing]. It is going to be over the top.

Chairman LIEBERMAN. Right.

Mr. PICKENS. Say you go with my plan and we do get on wind and we end up with, say, 400,000 megawatts in the central part of the country—let's talk about everything now. You have revitalized rural America at this point. You have helped the economy at this point. Now, what is the cost of your energy? I am guessing in 10 years you are going to be a long way down the track to an electric vehicle. But, remember, an electric vehicle does not do heavy duty. So you are going to have to continue to use natural gas will do heavy duty.

Chairman LIEBERMAN. Heavy duty, you mean the longer trips?

Mr. PICKENS. No. I am talking about 18-wheelers.

Chairman LIEBERMAN. Bigger vehicles, got you.

Mr. PICKENS. Heavy-duty vehicles.

Chairman LIEBERMAN. Right.

Mr. PICKENS. So you have to look at the whole thing. I think that your power costs in 10 years, you could—I am not sure you could get them down. You could get them stabilized maybe. But at that point—and you mentioned that there was only 1.5 percent on wind now.

Chairman LIEBERMAN. Right.

Mr. PICKENS. And that people are skeptical, you are not going to get too much on there. And then it is intermittent. But all these things are going to be solved. You are going to be able to store electricity. That is not too far in the future that we can store it. So I would say cheaper.

Chairman LIEBERMAN. Cheaper is good enough. It certainly is going to be a lot cheaper than it would otherwise be if we stuck with the status quo.

Mr. PICKENS. If you stick with the status quo—it will be much cheaper than that.

Chairman LIEBERMAN. Much cheaper.

Mr. PICKENS. Yes.

Chairman LIEBERMAN. Let me draw a few observations from what you have said this morning. The first point is an obvious one, but around here it is worth saying the obvious. You gave an example of what happens to a barrel of oil after a few months. We import it, it is refined, and it is gone. And then we have to go out and find another barrel.

The great thing—I know you know this; that is why you are recommending it—about wind and solar is that they are always there, the good Lord willing. So it is literally a renewable source. You have already put the whole thing on a different plane.

The other thing I want to say is that I appreciate the extent to which you have sketched a larger time horizon here. The Pickens Plan, as you have described it generally publicly so far, is a 10-year plan. Fair enough. And it is bold. And during that time, you have

said develop any energy you possibly can here in North America, stop importing oil. But you have now taken at least me this morning to a longer time horizon and a higher vision, and you have basically said that we need bridges to take us out to 2050 and maybe beyond because we are moving to a time when we are going to have just about a non-hydrocarbon-based energy system. It is going to be all the renewables, electric, biofuel, and all the rest.

Am I hearing you right? Because I think that is an important vision, and maybe it will be helpful to some people, for instance, right now who are concerned about offshore drilling. That is one way to have a bridge to somewhere better for our economy and our environment, getting to page 2.

Mr. PICKENS. Well, oil is the key to the conversation here as I see it, and oil is—we had produced 1 trillion barrels of oil at the turn of the century. It is kind of interesting because if you look at King Hubbert's extension, peak oil, and what would happen, the guy was great, in my estimation. I am a disciple. I don't think there are 2 trillion barrels of oil as I see it right now. Now, then you say take the oil shale on the western slope and you take this and that and everything. You can add up a bunch of stuff. When you add it up, it is going to be very expensive oil. But in looking at conventional oil—I live and you live and everybody in this room lives in the hydrocarbon era, and that era started with the automobile in 1900. Half of the oil that I see out there had been produced by the year 2000.

Now, we have another trillion barrels, and you say, well, that is another hundred years. No. You started slow, ramped up, and now the next trillion is going to go out of the system here within the next 50 years.

So you are going to be forced to abandon the hydrocarbon era. Can you imagine researchers 500 years out that come back and look at us? They are going to say, "That was a strange crowd. They lived on oil as a fuel." And that is not going to even be used at that point. Oil will be used and oil will still be around, but it will be used for other purposes and will be very special and very expensive; that is the way it is going to turn out.

But, yes, we are going to have to make it to the next fuel. But what is going to happen, if I am right on what I am trying to do, I am going to awaken the American people, and they are going to see what they are up against. When they walk out of a room, they will turn off the lights. They do not do that now.

Chairman LIEBERMAN. That all helps, doesn't it?

Mr. PICKENS. It helps. Every bit of it helps. I grew up in a home with a very frugal grandmother, and she said, "Sonny, if you don't turn the lights out, you are going to get the bill next month." And I turned off the lights. It made sense to me. Why not? If I am going to leave them on, I should pay for it.

So as it unfolds, we are going to become much more sensitive to energy in this country, and that is good. We are going to conserve. That is a big item. We are going to use different light bulbs. All these things count. Every bit of it counts. And so, as you unfold with this in mind, but if everybody understands, it is a lot easier to accomplish.

Chairman LIEBERMAN. Well, you have helped everybody understand. Incidentally, I had a very similar grandmother. [Laughter.]

Mr. PICKENS. Everybody must have.

Chairman LIEBERMAN. We are getting back to Grandma's wisdom now.

Mr. PICKENS. Yes.

Chairman LIEBERMAN. Thank you. Senator Collins.

Senator COLLINS. Thank you.

Mr. Pickens, you have made a very important point this morning when you stated that the cost of implementing your plan pales by comparison to continuing to export $700 billion year after year after year, in some cases to countries that do not wish us well. But do you have an estimate of what your plan would cost for achieving 20 percent of our electricity from wind?

Mr. PICKENS. I think I can give you a number. Let me see. You can go from my 4,000 megawatts to get to the number, and 4,000 megawatts ramped up to 200,000 megawatts, which would be 20 percent, would cost—it would cost about $500 billion.

Now, you say, well, wait a minute, that does not include the—let me have that other map that was up there.

Senator COLLINS. Does that include the transmission line?

Mr. PICKENS. It does not, but I am going to give you that number right here. If you can see the green lines on there, that is the Department of Energy's grid. And that grid, I believe they projected $70 to $100 billion. So now you are talking about a production tax credit of $15 billion; you are talking about the cost of the 200,000 megawatts is $500 billion; and you are talking about a grid of $100 billion. It is interesting. You are starting to approach 1 year's supply of oil that you are buying. But don't get the idea this replaces that oil. It does not. It will only replace 38 percent.

So it is a beautiful payout if that was it, and we would all love it if you said, "OK, Boone, do it," and I come back in here in 3 years, and you said, "Did you do it?" So we got it. We did it, and it is appreciated so much, you opening corridors. We did do it, and we have reduced it by 38 percent. That would be beautiful.

I am not sure I am that good, but I have confidence, and I know it has to be done.

Senator COLLINS. And you have talked about the importance of the production tax credit. It seems to me that it is critical that Congress stop letting the production tax credit expire. There is too much uncertainty about when it is going to be extended. Do we need a long-term commitment to the production tax credit to bring your plan about?

Mr. PICKENS. That would, I think, solve the PTCs. Yes, the long term would help. It would bring the manufacturers in because they would see you are committed, and it would bring in the money to develop. I have kind of broken new ground here, which I have credit doing that several times. Sometimes it did not make people very happy, but, anyway, I have gone out and committed to the 4,000 megawatts, and Shell Oil Company has done 3,000 megawatts. They are building a hundred miles southwest of me. So this is unfolding. And I think the biggest producer of wind energy now is Warren Buffett with his operation in the Midwest.

So, I mean, people believe in this. They know it will work. And if you do give an extension of the production tax credit, I think it would just accelerate the whole thing.

Senator COLLINS. And just to clarify the cost issue, obviously the production tax credit is critical for this investment to take place. But you are largely talking about private investment, correct?

Mr. PICKENS. I am talking about private investment. But if the government wanted to build a grid, I mean, do it. But if they don't want to do it, I think the money is there to do it privately. And so it is kind of like either do it or get out of the way, but give us the corridors to put it in, and it will be done.

You could put this on a very fast track if you wanted it to be on, and we have got to do it. There is no question we have got to do it. Are we going to do it fast, or is it going to be done over a long period of time?

Senator COLLINS. You were just talking with Senator Lieberman, quoting your grandmother on turning off the lights. How much of the solution also should encompass energy conservation?

Mr. PICKENS. Oh, it has got to be on page 1, of course. We have got to conserve. There is no question about that. We have been very wasteful. But in our defense, we had cheap oil. We had cheap oil. And as long as we had cheap oil—I don't know whether you have seen this guy—I think it is Jim Kunstler. But his last name is Kunstler, and it is not the guy that was the lawyer back years ago that was in the Chicago 7 or whatever it was. It is not that guy. But it is another person. I went over to Southern Methodist University (SMU) and heard him the other night. He is worth hearing. He is a generalist, but he tells us where we made the mistakes. We did not develop our rail system.

You look at the world today, we go places and we want to ride on a 200-mile-an-hour train. We have to go to a foreign country to do that. We don't have that. Why don't we have it? Because we had cheap oil. It didn't make sense for us to. It was expensive. We were going to subsidize it. And, it just didn't make sense for us. And he has got—we built too far away from our work. He says you are going to move to your work now because of the cost of energy. And it was really interesting because this was 2 years ago and the guy nailed it. I listened to what he had to say. I watched what has happened, and he was right on.

Senator COLLINS. Thank you.

Chairman LIEBERMAN. Thanks, Senator Collins. Senator Voinovich.

Senator VOINOVICH. Well, things have changed. We are in a global marketplace, and there are a lot of people who want what we have, and so we are paying more for it.

We do rely on foreign oil too much, about 60 percent of our oil coming from overseas. But one of the things—and maybe you are aware of this—is that we do send that money overseas, but some of the same countries that we are buying oil from are also investing in our debt. As a matter of fact, since 2001, 70 percent of the new debt has been picked up by China, Japan, and the OPEC nations. And I don't know about you, but I am worried about being at the mercy of people for our oil, and then before you know it, we are

at their mercy in terms of our debt. And if they try to put the squeeze on us, we are in pretty bad shape.

Mr. PICKENS. I agree.

Senator VOINOVICH. I went to some war games at the National Defense University, and they talked about the vulnerability that we have. And some folks out at Stanford said that in the next 10 years there is a 80-percent chance that the cut-off of oil will bring our economy to its knees. So we have a certain urgency that we have right now to get on with this.

Mr. Pickens, from a public policy point of view, as I mentioned to you, I did not have natural gas in the alternatives to oil. I had biofuels, ethanol, we have got to get cellulosic, electric hybrids, we are working on the batteries, fuel cells—we need hydrogen for the fuel cells—and natural gas. And some have contended that in terms of where we should put our money is in the area of electric hybrids for the simple reason that you do not need to build an infrastructure for them. In other words, if you go to natural gas, you have got to have places where people can get it. If you go to fuel cells, you have got to go someplace where you can get the hydrogen. And if we go to the plug-ins, you just go home at night and plug it into your electric socket.

What is your attitude towards that in terms of the infrastructure necessary to get us to that alternative so we do not have to rely so much on foreign oil?

Mr. PICKENS. This is the way I envision natural gas as a transportation fuel. We have 142,000 natural gas vehicles. There are 8 million in the world today. And you mandate the government fleets. Other fleets are mandated also to do the same thing. You have the Port of Los Angeles going to it very quickly now. All that can be done without—you don't have to subsidize that. That can be done between user and seller on that.

As far as your plugging in at home, of course, I think—listen, I am not knocking anything that happens in America. But the electric vehicle is not going to have very much range. But natural gas, you can plug in at home, too. In fact, my car, my Honda GX, I can plug in and my cost of fuel is $1.50 a gallon. I just buy the natural gas right off of my gas line that fuels my home and heats my home and cooks my food. So it is the same natural gas. I just have a small compressor. It is called a "fill" and it fills my car.

So these things I think are minor. One that is pretty interesting is Aubrey McClendon, CEO of Chesapeake Energy, and they are the biggest, I think, natural gas producer now in the United States. And Aubrey says, look, don't tax the oil companies, windfall profits tax, but also tell them that we will sidestep the tax, but you build the stations and take 25,000 filling stations and put an island for natural gas in it. Four hundred thousand dollars is what it costs, so $400,000 times 25,000 stations is $10 billion. And 25,000 stations, that will pretty well do it. But everything you——

Senator VOINOVICH. You think that they would be more likely to do that. We have tried to encourage these depots for ethanol, for example, and there are a few more of them, but not a whole lot. We have got all these E85 cars out there that can't go someplace and get it. So you are thinking that you are going to be able to get

the infrastructure to support natural gas a lot better than you would for ethanol?

Mr. PICKENS. Well, the point on that is ethanol is a light-duty fuel. Ethanol cannot work for heavy duty. But natural gas can. So I am approaching it from natural gas would be heavy duty, first and all, but when it comes to a passenger car, let it be up to the individual on a passenger car. If they want natural gas, if they want electric, if they want E80—whatever they want, they have. Don't mandate anything for them. Let them do it. They will the cheapest way is what will probably happen. But just let that unfold however it goes. But mandate to the fleets that they have got to go to natural gas and American fuel. The movement of goods in America, back to the same number again, 38 percent—38 percent of the fuel used in America is used to move goods. And that is with trucks. So you have 38 percent comes from the wrong foreign countries. You have got 38 percent we get with natural gas, and that moves the goods.

I think it works. If you said, can you assure me that it does, I know some part of it does. Enough of it does that we will be helped.

Senator VOINOVICH. I have a theory—and I don't know whether it is a good one or not, but I believe that if this Congress, hopefully working with the next President or maybe even before that, would make it clear to the world that we are going after every drop of oil that is available to us, that we are going to do everything we can, as I just mentioned, to have some type of a pilot project that we are going to become less reliant on oil, and that includes your proposal and a bunch of other proposals, that would send a real message throughout the world that the United States finally is dead serious about dealing with our energy and oil problem, and that would have some impact on the price of oil that we are paying for right now and in the future.

Mr. PICKENS. I was in the Middle East last year, and they don't understand why we don't develop our resources, and they don't understand why we keep telling them to produce more. I mean, it is a little bit confusing, the message that we send.

But think with me just a second. Let's say that had we developed ANWR 20 years ago and it went on production 10 years ago, it would have been halfway depleted now. So one thing about it, what we have not done we still have. And so I think that is interesting. Had we done it 20 years ago, the oil price would have been $15 a barrel. Today it is close to $150 a barrel. So the asset that we have not developed is worth 10 times as much as it was 20 years ago.

So that is pretty sobering, too, and I said I am ready to open it up, get everything we can. I think we would look a lot better to the world to develop our own resources than to say we are off limits but you are not. I think that is a hard sell, and it is not received well in the Middle East.

So, again, I know you are finishing up on me here. I think maybe you have some timer. But what we have got to do is we have got to do everything American. Whatever it is, we have got to do it and get off the foreign oil.

Chairman LIEBERMAN. Thank you. Mr. Pickens, that is a good note to end on. I really thank you for being here. You have been not only educational but I think motivational, which is what we

need to do. You are effectively putting a lifetime of experience in this field to work for your country in some ways that I suppose have surprised people. But you are not approaching it as an oil man—maybe in some ways you are because of that experience. You know the reality of the fact that we only have a limited amount of oil potential left in the world. Your recommendations are—actually, though they are visionary in one sense, they seem to me to be very practical in another sense and very balanced. And I not only thank you for this service to our country, but I hope you will stick with it. Knowing you, I know you will stick with it because I think in the end you have touched not only the nerve of a problem here, but also, if I may continue the anatomical metaphor, you have touched an American muscle, which is the muscle that when we see a problem, we have the ability, if we will it, to solve the problem to our benefit. That is the spirit you bring to the table, and may it reach the highest levels of our government and enable us to get something done really soon. Thank you.

Mr. PICKENS. I appreciate very much your time and your interest in what I have to say. But know this: I am first an American and second an oil man.

Chairman LIEBERMAN. Amen. And you know what? If everybody up here on Capitol Hill and elsewhere in Washington and in our government approaches it that way, I am first an American and everything else I am—Democrat, Republican, whatever else I am—is behind that because this problem is an American problem, and we can together devise an American solution. That is the road that you have shown us here this morning.

Mr. PICKENS. And, I have announced I am nonpartisan in this race. This issue is way above Democrat or Republican, and we need to approach it that way. I think we will approach it that way. I want to get it in this debate, and I want the American people to know.

Chairman LIEBERMAN. Thank you, sir. God bless you and good luck.

Mr. PICKENS. Thank you.

Chairman LIEBERMAN. We will now call the second panel of witnesses: Dr. Gal Luft, Geoffrey Anderson, and Dr. Habib Dagher.

Gentlemen, welcome to the table, and thank you for being here. That is a tough act to follow, but you have all been active and leaders in this area. As I said at the outset, I think you each have made some proposals that are bold as well and can inform what we hope to do here in Washington. So we welcome you. We thank you for being here. And, Dr. Luft, please proceed with your testimony.

TESTIMONY OF GAL LUFT, PH.D.,[1] EXECUTIVE DIRECTOR, INSTITUTE FOR THE ANALYSIS OF GLOBAL SECURITY, AND CO-FOUNDER, SET AMERICA FREE COALITION

Mr. LUFT. Thank you, Mr. Chairman, Senator Collins, and Senator Voinovich. I was not planning on responding to the Pickens Plan, but I am afraid that in light of what I have heard today, I would like to make some comments on the plan because I think

[1] The prepared statement of Mr. Luft appears in the Appendix on page 58.

that there are some serious mischaracterizations that we heard here today.

The most important one is that when we talk about national security, we need to realize that 63 percent of the world's natural gas reserves are in the hands of Russia, Iran, Qatar, Saudi Arabia, and United Arab Emirates. These countries are now in the process of developing and discussing the establishment of a natural gas cartel. So shifting our transportation sector from oil to natural gas is like jumping from the frying pan into the fire. This is a spectacularly bad idea for us to shift our transportation sector from one resource that we do not have to another that we do not have. And we only have 3 percent of the world reserves of natural gas. The situation is very similar to our situation with regards to oil. So we do not want to give at this point in time a gift to Iran.

Second, one good thing that happened after the 1973 embargo is that we weaned the power sector from oil. We no longer produce electricity from oil, unless you live in Hawaii; and, therefore, solar, wind, nuclear, all these sources of energy have nothing to do with our oil dependence. Unless we have serious deployment of electric cars, these sources of energy are irrelevant.

Now, Mr. Pickens says that we take 20 percent of our natural gas and replace it with wind. I am sorry, but our energy system is not a Lego. You do not take one cube and replace it with another. If we increase wind production, which is an excellent idea—excellent idea, we should do it—nothing guarantees that it will displace natural gas. It could displace coal. It could displace solar. It could displace geothermal. How do you control what the wind will displace.

Just food for thought, and I want to move into the things I really want to talk about and start by agreeing with Mr. Pickens that we have a serious problem. Just to remind the Committee that 10 years ago, Osama bin Laden predicted that oil would be $144 a barrel. Everybody laughed at him. Oil was only $12 a barrel at the time. He was right, and as a result, we are exporting hundreds of billions of dollars. This is the first year that we actually are going to pay foreign countries more than we pay our own military to protect us.

So in order to understand what should be the road to energy security, we must first understand why we are where we are. There are many reasons why we have the oil crisis now. Of course, strong demand in developing Asia, speculation, geological decline, geopolitical risk, all of them have contributed their share. But, in my view, by far the main culprit is OPEC's reluctance to ramp up production. This cartel owns 78 percent of the world's proven reserves, and it produces about 40 percent of its oil production.

If you refer to page 2 of my testimony, you will see that in 1973, OPEC produced 30 million barrels of oil every day. Today, OPEC produces 32 million barrels of oil every day. In other words, OPEC today produces almost as much oil as it did 35 years ago. Even though the world economy almost doubled, non-OPEC production almost doubled, OPEC included last year two new members—Angola and Ecuador—and they still produce almost the same amount of oil as they did 35 years ago. This is a scandalous practice, and

we are stepping on our toes not telling OPEC that they are the main culprit behind everything that is happening now.

Clearly, it is not in OPEC's interest to provide relief to the struggling global economy. The cartel enjoys a vertical monopoly of the world vehicle fuel supply, and it is currently at the receiving end of the biggest transfer of wealth in human history.

Our energy security problem stems from the fact that our transportation sector is dominated by petroleum. And while being in a hole, we continue to dig. We put on the road annually 16 million new cars, almost all of them gasoline only, each with an average street life of 16.8 years. A Senator elected in 2008 will witness the introduction of 102 million gasoline-only cars during his or her 6-year term.

The source of our predicament is that we have a cartel married to a monopoly, and if we want to solve our energy security problem, we must break both the cartel and oil's monopoly in the transportation sector. This means that neither efforts to expand petroleum supply nor those to crimp petroleum demand through increased Corporate Average Economy Fuel (CAFE) standards will be enough to reduce America's strategic vulnerability. Such non-transformational policies at best buy us a few more years of complacency, while ensuring a much worse dependence down the road when America's conventional oil reserves are even more depleted.

To those who believe that increased domestic drilling is the solution, I propose to take a look at page 4 of my testimony, where you see OPEC's graph that clearly shows that when we drill more, they drill less. That is the history of the past 35 years.

Rather than focusing on solutions that perpetuate the petroleum standard, we should invest in transformational policies that aim to diminish the strategic importance of oil by breaking its monopoly in transportation. We should do to oil what was once done to salt. Throughout history, salt was used to preserve food, enabling armies to march across continents. Those who owned the precious mineral acquired wealth and international prestige. Those who did not had to either pay for it or fight for it, just like with oil today. Salt-rich domains like Orissa, Tortuga, Boavista, and Turk Island enjoyed great strategic importance equivalent to that enjoyed today by city states like Dubai and Abu Dhabi. All this ended with the invention of canning and refrigeration. Salt is no longer a strategic commodity shaping global trends. It is just another commodity.

The first thing we must do is to turn oil into salt and to ensure that the cars rolling onto America's roads are platforms on which fuels can compete. For the cost of $100 extra, automakers can make virtually any car a flex-fuel vehicle, capable of running on any combination of gasoline and a variety of alcohols such as ethanol and methanol, made from a variety of feedstocks.

Now, we are all familiar with ethanol, and everybody has an opinion about it. But I would like to talk here about another alcohol that China is actually deploying at the moment, and that is methanol. Methanol today is China's alternative fuel of choice. Several provinces in China are already blending their gasoline with methanol, and scores of methanol plants are currently under construction there. The Chinese auto industry has already begun producing flex-fuel models that can run on methanol. Methanol packs

less energy per gallon and is more corrosive than ethanol. But it is cheaper and far easier to produce in bulk. While ethanol can be made only from agricultural products and biomass, such as corn and sugar cane, methanol can be made from agricultural waste, coal, industrial garbage, natural gas, and even carbon dioxide. Yes, in my view, this is perhaps the most promising way of dealing with our carbon dioxide problem, is turning it into methanol.

Electricity is key to the solution. As I said before, we do not produce electricity from oil, but if we shift to electricity as a transportation fuel through massive deployment of electric cars and plug-in hybrids, that will make a huge difference. A plug-in hybrid car does about 100 miles per gallon of gasoline. If this plug-in hybrid is also a flex-fuel car, you add the $100 feature, and you get 500 miles per gallon of gasoline. Not 500 miles per gallon, but 500 miles per gallon of gasoline. A nationwide deployment of flex-fuel cars, plug-in hybrids, and other alternative fuels can take place within two decades. But such a transformation will not occur by itself.

On the grounds of national security, Congress should take swift action to require that new vehicles sold in the United States are flex-fuel vehicles through an Open Fuel Standard. Such an Open Fuel Standard would level the playing field and promote free competition among diverse energy suppliers. I am delighted that shortly after this hearing, Open Fuel Standard legislation will be introduced by a bipartisan group of Senators, which includes both the Chairman and the Ranking Member. This is an important piece of legislation and, in my view, the best way, the best mechanism to break OPEC's monopoly in the transportation sector. By making America a flex-fuel vehicle market, we will effectively make flex-fuel the international standard as all foreign automakers would be impelled to convert their lines over as well.

Around the world gasoline would be forced to compete at the pump against alcohol fuels made from any number of sources, including not only commercial crops like corn and sugar, but also biomass, coal, natural gas, and recycled urban trash.

I realize that many are opposed to any government interference in the market, even if it only means adding $100 to the cost of a new car. Indeed, in a perfect world, government would not have to do things like that and intervene in the energy market, but in a time of war, the United States is taking an unacceptable risk by leaving the problem to be solved by the invisible hand. Choosing not to embrace an Open Fuel Standard is choosing to preserve oil's monopoly in the transportation sector and, with it, OPEC's growing stranglehold over the global economy and in essence guaranteeing continuous economic and strategic decline.

Chairman LIEBERMAN. Thanks, Dr. Luft. A lot for us to think about and do.

Geoffrey Anderson is President and Chief Executive Officer of Smart Growth America. It is good to see you again. We welcome your testimony now.

TESTIMONY OF GEOFFREY ANDERSON,[1] PRESIDENT AND CHIEF EXECUTIVE OFFICER, SMART GROWTH AMERICA

Mr. ANDERSON. Thank you, Mr. Chairman, Senator Collins, and Senator Voinovich, for having a hearing on such an important topic.

I think a lot of the focus to this point has rightly been on the transportation sector and on what we can do with respect to supply. But I think we need to think about this charge in a broader sense, and it is really about reducing dependence on oil, reducing climate emissions, ensuring that we actually help consumers to save money at the pump, and helping the economy at the same time. And so I think when we start to think about that, we also need to think about the demand side and some of the conservation things that T. Boone Pickens began to talk about. And that is where Smart Growth comes in.

I think the real opportunity out there right now is to allow people to drive less and to be able to do more. And we can do that by essentially building more walkable and more complete communities. A lot of the growth in oil use has been as a result of spread-out, driveable landscapes that really do not give you any options besides driving. And there is a real move now to create more walkable communities where homes are closer to jobs, shops are closer to work, and all of these things can be reached either on foot, by bike, with transit, or by shorter car trips.

I want to talk a little bit about a project called Atlantic Station because I think it does a lot to illustrate what we are talking about here, and the potential. It is a $4 billion redevelopment of a brownfield site in midtown Atlanta, basically done entirely for economic reasons. The developer wanted to make money. He thought there was a market out there and put in basically 10 million square feet of commercial, retail, office, 3,000 to 5,000 units of housing very close to transit, all in a walkable neighborhood. When the EPA calculated what the emissions impacts would be, the calculations were that residents would drive approximately 27 miles a day compared to the average Atlantan who drives around 34 miles. Recent studies of that neighborhood, in fact, show that people are now driving about 9 miles per day just because their car trips are shorter, the places they want to go are in closer proximity to the places they live, and it also obviously has climate implications as well.

The total savings on a yearly basis run in the neighborhood of around 50 million miles of travel every year just from that development compared to what the driving characteristics would have been in the event that it was built in a more normal Atlanta pattern.

If you look at what that might translate into over a period of time or over a larger scale, we can expect—and this is from a publication done by the Urban Land Institute called "Growing Cooler"—that each increment of more compact, walkable development leads to about a 20- to 40-percent reduction in vehicle miles of travel. If you project that out over the time frame to 2030, if you shift a significant share of new growth to compact patterns, you can actually

[1] The prepared statement of Mr. Anderson appears in the Appendix on page 64.

save 85 million metric tons of carbon dioxide in 2030. It is equal to about a 28-percent increase in CAFE standards and roughly half the savings of the Senate's 35-mile-per-gallon CAFE bill. So it can be significant.

The cost savings were calculated in the $24 billion range for consumers in the year 2030 or cumulative savings of around $250 billion. And by 2050, you could expect a 7 to 10 percent total reduction in carbon dioxide emissions accompanying driving and oil consumption really as a result of shifting some portion of our new growth over the smarter development patterns.

A Natural Resources Defense Council (NRDC) analysis looked at just what would happen if you looked at a 10-percent shift of new growth to more walkable patterns and found that you could save around 4.95 billion gallons of gasoline, 118 million barrels of oil, and roughly $220 billion worth of household expenses. That was, of course, calculated in 2004, so I think the household expense number would be a little higher today.

If those savings are available at scale, what is the likelihood of getting there, and does the market want to go there? And what our research indicates and research from others in the real estate field indicates is that about a third of the market is interested in having more walkable communities, more compact communities. The fact is that for the last 50 years, we have essentially built drive-only communities, so the two-thirds of the market that really is interested in that product is well provided for. An analysis by Chris Nelson at Metropolitan Institute at Virginia Tech indicates that, in fact, from the perspective of market supply, we probably already have the demand met that will occur in 2025 for large-lot single-family houses. The unmet demand is really in the area of smaller single-family houses on smaller lots, condominiums, apartments, and so forth. And there are a couple trends driving this. One is what they call in Minnesota—or at least that is where I heard it—the "silver tsunami," the changing demographics where households are very different than they were even 20 or 30 years ago.

In 1960, roughly half of American households had children. In 2025, that is expected to be around 28 percent, with around 28 percent of households being single individuals. So the market is definitely changing, and that is why some of the market demands are changing and why the supply is so out of balance right now with the demand and the projected demand.

It is true also in the retail sector that commercial products are changing as well. We have seen a vast drop-off in the big-box mall out in the middle of a parking lot, and a great increase of basically walkable, more town-center-style retail. So the market is really moving in this direction, and there is a big opportunity for the Federal Government to basically enable some of this. It is important for two reasons. One, with the market moving in this direction, I think there is opportunity for the private sector to really take advantage of that market demand and build the communities that will help consumers to be able to drive less and accomplish their daily needs. But it is often the hardest thing to do from a market perspective. The Atlantic Station development took years and years to get through regulatory barriers, to get through brownfield barriers, to address market institutional barriers of finance. And so

from the development perspective, it is often the hardest product to build. It is zoning regulations at the local level. It is how we fund infrastructure at the State and national level, and a variety of other things.

So the Federal Government has the opportunity essentially now to promote what the market is asking for in a way that will help to reduce the vehicle miles of travel that result from those developments. And I think there are a couple of actions that have been helpful in the past. The brownfields law, the clean-up programs, and the tax incentives for brownfields redevelopment have had a big impact, and I think a lot more could be done there. The historic preservation tax credits help to drive development to more infield locations where the market demand wants to move. The investments in transit, biking, and walking facilities are important public sector investments where the private sector responds to those by building communities that match those kinds of investments.

In terms of the existing Federal legislation right now, I think obviously the climate legislation included some measures for funding transit and walkable communities, but I think that can be greatly increased. The new transportation bill that the Congress will be visiting probably in 2009 or 2010 is going to have real opportunities to invest in world-class transit, pedestrian, and bicycle infrastructure to make better connections between land use and to incentivize the building of more walkable neighborhoods that give people choices about how they get around, give them the opportunity to avoid high gas prices, and the opportunity to reinvest in our existing communities and infrastructure, and then to connect those communities, many of which are connected by short plane flights or by long-distance auto commutes, instead connecting them by rail and maintaining the economic synergies that currently exist between those places.

I will wrap up there, and thank you for the opportunity to speak with you today.

Chairman LIEBERMAN. Thanks very much, Mr. Anderson. Very interesting testimony, and I look forward to asking you a few questions.

Dr. Dagher, it is a pleasure to have you here. Dr. Dagher is a professor of civil and structural engineering at the University of Maine, which we on this Committee know as one of America's great public universities, and director of the university's Advanced Structures and Composites Laboratory.

We thank you for being here and invite your testimony now.

TESTIMONY OF HABIB J. DAGHER, PH.D.,[1] DIRECTOR, ADVANCED STRUCTURES AND COMPOSITES LABORATORY, UNIVERSITY OF MAINE

Mr. DAGHER. Thank you, Chairman Lieberman and Ranking Member Collins. Thanks for inviting me, Senator Collins, to be here today.

I would like to start this testimony by acknowledging the inspiring role as a system architect, my colleague, George Hart, as well

[1] The prepared statement of Mr. Dagher appears in the Appendix on page 71.

as Matt Simmons, who is well known for alerting our country to peak oil and peak oil issues.

You have heard about the financial, geopolitical, and security dimensions of our energy crisis. I would like to put a human face on this crisis. Maine will likely be the first State to experience a heating state of emergency. I say that with confidence because we are living it right now, and Senator Collins has been very concerned about our future.

Some statistics about Maine. Eighty percent of Maine families use heating oil to heat our homes, and heating oil costs are tracking those of crude. Next winter's heating oil costs will be $5 a gallon if you try to lock it today. That means the average Maine family will pay $5,000 a year just to heat their home next winter. In 2020, if we do not do anything, if we do not do the Pickens Plan or any other plan, those numbers will be $10,000 a year just to heat our homes.

If you look at Chart 4 in the testimony, it shows you in red how much of the Maine family budget actually goes to energy. Ten years ago, less than 5 percent of the Maine family budget went to energy. Today, close to 25 percent, a quarter of the Maine family budget, goes to paying for energy. That is transportation, that is heating, that is electrical power. In 10 years, if we do not make any changes, about half of the Maine family budget would go to energy. Clearly, this is not sustainable. The State of Maine pays close to $5 billion a year in energy costs, and we only have a little over a million people.

So what is the solution? You have heard about T. Boone Pickens' wonderful plan, but we sit in the corner of the country, and we are not very close to the wind belt that runs up and down from Kansas to Texas. So what do we do? And we have actually been working very hard on solutions for our State.

If you look at page 4 of the testimony, according to the National Renewable Energy Lab (NREL), the offshore wind potential, the offshore wind energy, the energy that blows over the oceans, if you wish, is a tremendous natural resource, a resource we did not really understand until recently. The offshore wind is about equal to the U.S. electric production today.

If you look at other ocean energy resources, we have heard about tidal energy. Tidal energy and wave energy are actually a fraction, a very small fraction of the offshore wind resource.

If you take a look at the second sketch on the right-hand side, it shows another very powerful point about the offshore wind resource. It sits very close where the need is. If you look at the U.S. population densities shown in dark red, and if you look at the offshore wind resource, it is where the people are. So we don't need to build a large transportation infrastructure to get the wind energy to the people where they need it. That is one major advantage of that resource.

Maine, of course, has a tremendous offshore wind resource. The Gulf of Maine has been called the Saudi Arabia of wind in many ways. There is over 100 gigawatts of wind power in the Gulf of Maine. That is about 10 percent of the total U.S. electric power production.

So how do we go get it? One major advantage of that resource, it is also a seasonal resource. It is actually high when we need it. We need to heat ourselves in the State of Maine and in the Northeast, and the heating costs are our biggest issues. But in the wintertime, the wind blows twice as fast as it does in the summertime, and the power generated from the wind is the cube of the wind speed. So in the wintertime, per month, we can generate 8 times as much power as we do in the summertime. You can think of wind off the coast of Maine as a seasonal crop right now that can help us heat the State of Maine.

I would like to talk more about what we are proposing for the Gulf of Maine and how it fits in with T. Boone Pickens' vision. Actually, it fits in very well with his vision. If you look at the left-hand drawing here that we have, Mr. Pickens essentially is talking about the U.S. wind corridor you see up and down from Kansas down to Texas. That is a wonderful resource that can generate 200 to 400 gigawatts, depending on how much of it you think you could use. We are talking about adding three more wind regions to the Pickens Plan, and the three wind regions are the Atlantic Ocean wind region that can generate between 120 and 240 gigawatts, and then we have the Pacific Ocean wind corridor that can generate 75 to 150 gigawatts, and then the Great Lakes corridor that generates 110 to 220 gigawatts. So rather than go to 20 percent, as Mr. Pickens is saying, maybe we can go to 40 percent with this additional resource, and it is very close to where people actually need it.

The other major advantage of having this distributed corridor is the fact that the geography allows averaging of the uncertainty of the winds and the intermittency of the winds, so you have less intermittency as the weather moves from the west to the east. There is always some bad weather somewhere. You are always going to pick up some wind. And that reduces the uncertainty, if you wish, in the wind profiles.

But it is more than just generating wind. It is how to use the wind, how to actually take that wind and make the best use out of that electricity. We are proposing very efficient ways to store and utilize this electricity that have profound effects on efficiencies. We are talking about efficiencies on the order of two to four that could be achieved by using essentially heat pumps—heat pumps, whether they are ground loop heat pumps—as you know, the temperature below the Earth, 10 feet below the Earth stays close to 45 degrees Fahrenheit. It is a wonderful place to go get some calories and bring them into the house. You do not have to generate those calories. They are there. And that is what we are trying to do here. We are trying to use the electricity we generate from wind and bring it into the house, shift it into the house, rather than generate it using electricity. And that can get you, depending on the time of the year and the temperature outside two to four times the benefits.

Another major advantage is storage. If you look at plug-in electric vehicles—we have all been talking about them, but one thing we have not talked about is that the majority of our energy usage actually is in transportation. Fifty percent of the energy budget for the family in Maine is in transportation; 40 percent is in heating. So if we can cut that transportation part out by using electric plug-

in vehicles, and use them as a distributed battery that can store energy at night—when you go at night and you plug in your car, the wind can be high, it can be low, you can still charge your car. And then you can use it the next day. So it is a wonderful distributed battery that could be used to even out the intermittency of the wind.

Are we the only ones who are doing this? Well, if we look across the Atlantic, unfortunately the Europeans are way ahead of us. Again, they have been scratching their heads long before we have. They have been paying $7, $8 a gallon long before we have. So they are looking at solutions.

In Europe, there are plans by 2030 to generate 150 gigawatts of offshore wind capacity for Europe—150 gigawatts, that is number 16 on the chart. They are calling wind energy and offshore wind the "Third Industrial Revolution." They have created over 300,000 jobs in Europe in wind and wind-related businesses. We can do the same. We can do the same by driving in the direction of renewables as well.

What is it going to take to go offshore? And if you look at going offshore, it is almost like the reverse Darwinian motion here. We are actually going from land with wind technology over to offshore. And what is it going to require? It is going to require developing floating platforms because the Continental Shelf in the United States drops off very quickly. Ninety percent of that wonderful wind resource sits far offshore and in deep water. So we need to develop these tension-leg platform type solutions, and you can see some of these structures on page 6.

So we need a research and developement (R&D) program to be able to transfer some of that technology from Europe to the United States and also transfer decades of deepwater offshore drilling experience into the wind energy market.

We have a detailed $100 million R&D plan that we are proposing that is in your sheets, but I would like to summarize here very quickly. Offshore wind is a wonderful U.S. natural resource. It sits closer to where people need it. If you look at where the population centers are, it is very close to them. We do not need to build large transmissions to get to those locations.

We need your support to create a national Offshore Wind Energy Initiative, a Manhattan Project for offshore wind energy that can double the Pickens Plan. We are ready to lead that in the State of Maine because, you know what? We are in the eye of the heating hurricane. That is where Maine is right now. We are prepared to lead the Nation already if a national program is created.

The other thing we would like your help on is to develop the financial incentives, the PTCs, make sure those stay in place, and also develop a policy framework to allow the offshore wind developments to take place. Thank you very much.

Chairman LIEBERMAN. Thanks very much, Dr. Dagher. That was actually very exciting testimony. I appreciate it very much.

We will do a 6-minute round. There is a vote that has gone off on the Senate floor. I think Senator Collins will go first and then hopefully be back before long, and then we will go from there.

Dr. Luft, let me take advantage of your presence here to just ask you to say a bit more about the Open Fuel Standard Act—which

Senator Collins and I, with Senator Brownback and Senator Salazar, are going to announce the introduction of at noon today—and explain specifically how its provisions would promote the fuel diversity that you and I and others believe is necessary to break the stranglehold that oil has on our economy.

Mr. LUFT. Basically what the bill does, it requires that 50 percent of new cars sold—not produced, sold—in the United States must be flex fuel by 2012. That is the first benchmark. And the 50-percent figure actually comes from the auto industry itself. In multiple meetings of the Big Three with both congressional leadership and the President, they themselves said that they are willing to make 50 percent of new cars flex fuel by 2012. So the bill basically takes their numbers and codifies it, makes it into a law.

It has a second benchmark of 80 percent by 2015, but the important thing is that we have the 50-percent commitment today and that the fuel flexibility is not only for ethanol, but we have also methanol and other alcohols that can play a role in the transportation sector, and today they are excluded.

Now, let me explain. An E85 car, the one that is made today by Detroit, can only run on ethanol. It cannot run on methanol because methanol is slightly more corrosive. If the cars are what we call GEM flex fuel—gasoline, ethanol, methanol—that includes all of the alcohols, and that means that you have much more fuel choice, and also you can introduce other feedstocks that can go into alcohol production, like coal, natural gas, garbage, and carbon dioxide, as I said before. So you have a much more scalable solution, and that is a good way to introduce fuel choice in the transportation sector because today we do not have choice. It is gasoline, gasoline, and gasoline. That is all that plays.

We also believe that within 3 years of the introduction of the Open Fuel Standard, we will have almost 50 million flex-fuel cars on the road. At this point it makes perfect sense for the distribution system to follow because today gas station owners don't want to convert their pumps because there are not enough cars on the road. But once every fourth or fifth car on the road is a flex-fuel and we have continuously high oil prices, it makes perfect sense for them to do it.

Chairman LIEBERMAN. Where does electricity fit in then, electricity-driven cars?

Mr. LUFT. On the electricity front, the energy bill that was passed in 2007 had some terrific provisions for plug-in hybrids. The only thing that is missing now are the tax incentives, and that is part of the tax package that hopefully will be resolved one way or another. But I think that we have made significant progress on electrification of transportation, and now what we need to do is to deal with the liquid fuel market by introducing this Open Fuel Standard.

Chairman LIEBERMAN. Just for the record, can a car be both flex-fuel and have the option of being powered by a battery?

Mr. LUFT. It should. Once you have a plug-in hybrid car, making it also flex-fuel just means adding $100 to the car. All you need is a different fuel line of corrosion-resistant materials that enable the car to run also on alcohols. It is not one or the other. It should be both.

Chairman LIEBERMAN. Should our aim be to get to 100 percent by a date certain?

Mr. LUFT. Well, I think that it would be nice if we had 100 percent. I think 100 percent could be difficult. But I think if we have the 50 percent going to 80 percent, then you certainly create a market, and that will move the whole system forward.

Chairman LIEBERMAN. OK. Dr. Dagher, you mentioned that Europe is ahead of us in the development of offshore wind energy. Tell the Committee a little bit more about how you would characterize the maturity of offshore wind here in the United States. How much electricity is now being produced by offshore wind?

Mr. DAGHER. In the U.S.——

Chairman LIEBERMAN. Yes, that is what I meant.

Mr. DAGHER [continuing]. At this particular time, there is no production of electricity.

Chairman LIEBERMAN. Really it is zero.

Mr. DAGHER. It is zero at this point.

Chairman LIEBERMAN. So the notorious wind farm off of Nantucket, was it, that never—nothing has happened there.

Mr. DAGHER. Certainly it has not materialized yet. There are hopes that it would materialize.

Senator CARPER. Would the Chairman yield?

Chairman LIEBERMAN. Please.

Senator CARPER. Twelve miles off the coast of Rehoboth Beach, Delaware, the wind farm is coming.

Chairman LIEBERMAN. It is coming?

Senator CARPER. Yes, we have worked it out.

Chairman LIEBERMAN. Really?

Senator CARPER. And we are inviting Maryland and maybe New Jersey to consider joining us.

Chairman LIEBERMAN. That is great.

Senator CARPER. We are excited.

Chairman LIEBERMAN. Thank you, Senator Carper. Good news.

Mr. DAGHER. Yes.

Chairman LIEBERMAN. What is the state of the technology? In other words, is there a lot of R&D that still has to be done to make this work, particularly further offshore?

Mr. DAGHER. That is correct. If you look at further offshore right now, there are no commercial installations of further offshore wind energy, even though 90 percent, if you wish, of the U.S. offshore wind energy is in deep water. So, yes, there are major R&D efforts needed. There are currently a number of companies worldwide that are pursuing the effort. StatoilHydro has recently invested $80 million in their first demonstration structure.

What needs to be done? There needs to be a public-private effort, government and industry working together to go in that direction. However, we believe in the next 5 years to 7 years, if the R&D dollars are in place, we should be able to go deep offshore.

Chairman LIEBERMAN. Thanks. My time is up, and also my time will be up over there if I do not move. So I am going to temporarily recess the hearing. Don't go very far because I expect Senator Collins will come back, and she will begin again and then I will return.

Thank you.

[Recess.]

Senator COLLINS [presiding]. The Committee will come back to order. In the Chairman's absence, I am going to proceed with his permission to my questioning, and, Dr. Dagher, we will start with you.

First let me say to the entire panel that your testimony is very helpful to us. When I look at all the testimony we have heard today, I cannot help but think that all of the above are part of the answer, that it is not just one piece. We have to have a very comprehensive approach.

Dr. Dagher, as you know, it has been difficult to do siting of wind energy, both on land and in the case of Massachusetts, offshore as well. Therefore, I want to clarify a point about the plan that you have presented.

As I understand it, these turbines would not be visible from the shore. Is that accurate?

Mr. DAGHER. That is accurate, Senator Collins, yes.

Senator COLLINS. So how far offshore are you talking about locating these turbines?

Mr. DAGHER. We are looking at 20-miles-plus offshore, which because of the curvature of the Earth, would make these invisible, and specifically to address the issues that you have been concerned about is how do we get over the Nantucket problem. It is really what we call "out of sight, out of mind" turbines, in many ways. A lot of people do not want to look at these turbines from their land onshore, and by getting them out where they are 20 miles off, we avoid some of these issues. But also we pick up the wonderful wind resource that happens to be at that distance.

Senator COLLINS. I am very excited about T. Boone Pickens' plan, but I do not think it is the whole answer. It seems to me that the plan that you have outlined using offshore wind and geothermal are really complementary to his plan. Is that your assessment?

Mr. DAGHER. That is correct, Senator Collins, yes. T. Boone Pickens' plan utilizes the wind corridor from the Dakotas down to Texas to generate anywhere from 200 to 400 gigawatts, depending on how much you want to generate. But that leaves us out, if you wish, on the east coast and on the west coast unless we build very expensive transmission systems. The majority of the U.S. population, actually close to 28 States, utilize more than 70 percent of the Earth's electricity around the coasts of the United States. So the major demand for electricity is around the perimeter of the country.

Senator COLLINS. So, actually, your plan helps to provide increased access to renewable electricity closer to the population centers. The Pickens Plan goes through the very center of the United States, but as I understand it, electricity loses—there are line losses the further away from the source of electricity. Is that accurate?

Mr. DAGHER. That is accurate.

Senator COLLINS. You are the engineer here.

Mr. DAGHER. That is correct. Yes, there are line losses that take place, and, of course, there are transmission costs as well that go along with that. And building transmission lines in heavily populated areas is very expensive as well from a permitting viewpoint

and so forth. And if you look at the population centers on the east coast, for example, the Midatlantic States and up in the New England area, it would be very costly to build transmission lines in those areas. Therefore, siting some of this renewable resource offshore allows us to get directly to where the population centers are and avoid the congestion.

Senator COLLINS. Thank you.

Dr. Luft, I want to go to your point about the transportation sector because, clearly, converting cars has to be an essential component of our energy security policy. And I would be interested in your concerns about Mr. Pickens' plan to use natural gas. What would you think of the Federal Government having a mandate on itself to say that the Federal fleet has to be comprised of flex-fuel cars, plug-in hybrids, as well as natural gas-fueled cars by a certain date? Let me tell you why I am asking you this question.

Mr. Pickens made the point that in the United States we have only a very small percentage of our vehicles using natural gas. Well, you could go beyond natural gas and say we have a very small percentage of our vehicles that are not dependent on gasoline more broadly. If the Federal Government helped to lead the way, would it help spur the infrastructure that we need to fuel these alternative vehicles? And would it help encourage manufacturers to also meet this demand?

Mr. LUFT. Well, first of all, the Federal Government has already committed itself years ago, and the problem today is with compliance rather than commitment. So let's first of all focus on compliance of rules and regulations that have already been introduced years ago and make sure that Federal agencies are actually in full compliance.

I think that there are certain limitations to certain Federal agencies realistically that need access to the fuel if they do not have infrastructure, which is why I think the lowest-hanging fruit is the flex-fuel because a flex-fuel mandate only adds a small feature to the car. It is very cheap. It should be, across the board, not only added to the Federal fleet but to every car sold in America.

Quite frankly, one of the reasons, I think, that methanol should be in the picture, if Mr. Pickens is so interested in natural gas, you should know that almost all of our methanol today is produced from natural gas. So that is a good way to use indirectly natural gas in flex-fuel cars by using methanol, which can be made from other things but also from natural gas. And that is, again, this $100 feature that makes the car capable of running on those fuels. That is the very low-hanging fruit, and thank you for being part of it.

Senator COLLINS. In your testimony, you had a wonderful comparison that the Federal Government is subsidizing converter boxes so that people do not lose the signal on their television sets come next year when the conversion to digital takes place. It is ironic that we do not do more to help people convert their automobiles to flex-fuels when an investment of just $100 per vehicle could make such a difference in the energy consumption of our country. You did not use that analogy in your oral presentation today, so I just wanted to bring it up for the record since, arguably, helping to reduce our dependence on foreign oil is more important

than helping to ensure that people can still watch television—or some would argue, anyway. So I thought that was a good point.

Mr. Anderson, your emphasis on community planning and the design of our housing and our downtowns is very interesting, and I also think it is part of the solution. However, if you come from a large rural State like mine, it seems somewhat less relevant than it would to a more congested urban area.

What can a large rural State learn from your findings?

Mr. ANDERSON. I think actually there is a lot of application. Before this position, I was at the Environmental Protection Agency actually running the Smart Growth Program there, and a lot of the technical assistance we did there was in more rural locations—Laconia, New Hampshire; Pamlico, North Carolina; Cheyenne, Wyoming; Victor and Driggs, Idaho. A lot of small towns really are looking at how they are growing and asking the question—I mean, in many ways it is the suburban and rural areas that are most vulnerable to rising gas prices because of the lack of options from being able to drive. And the most significant change we have seen, I think, in the short term has been increases in transit ridership. We are seeing transit at 50-year high. We have seen actual drops in vehicle miles of travel over the last year. So people are changing their behavior, and it is happening in the places you would expect, with a lot of transportation choices and a lot of public transportation. But it is also happening in smaller towns and rural areas. And the kinds of transit options, the kinds of public transportation options you would want to look at for smaller rural towns and areas are different, but they are out there, and the models exist for systems that would be applicable to those places.

And so I think also looking at not only the work trip but the nonwork trip, there tends to be a great deal of focus on the energy and the oil and the gas associated with getting to and from work. But when you look at the trip profile, that tends to be, depending on how you want to count, only 25 to 35 percent of all the trips a household takes.

So just making more complete communities where kids can walk to school, where schools are the centers of the community, where you can do some of your daily errands with a short car trip rather than a long one can make a big difference. If you look, for instance, back in 1960, about 50 percent of kids walked to school. That number is now down to about 11 percent. So just the basic way that we are building and shaping our communities is, in fact, locking us into one transportation option and essentially locking in oil dependence in the transportation sector.

Senator COLLINS. Thank you.

Dr. Dagher, you made a very interesting point that your plan could not only help to reduce our dependence of foreign oil and bring some stability and lower prices to the citizens of our State who are really struggling with the high cost of heating oil, but it also could be an economic benefit. Could you talk a bit more for the Committee about the possibility of what some have been referring to as "green jobs"?

Mr. DAGHER. Yes, indeed. You are absolutely correct, Senator Collins. By solving the heating crisis that we have in the State of Maine and the energy crisis, we can also create a lot of renewable

energy jobs. Now, Europe is a perfect example here. We do not need to really look into the future. We just need to look across the Atlantic.

Europe has created over 300,000 jobs over the last 10 years in wind and wind-related energies because 70 percent of all wind turbines in the world are now produced in Europe. We can do the same. But they have put together a policy system that allows industry to invest. They have the tax credits in place; they are very stable. So putting together the policy framework that would allow for these renewables to move forward is critical.

Numbers, in terms of how many jobs are created per gigawatt installed, vary quite a bit, but those numbers are anywhere from 1,000 jobs to 5,000 jobs per gigawatt of wind energy installed.

Senator COLLINS. Those jobs would be welcome indeed.

Senator Lieberman, before you came in, I started my questioning by saying that I think we need all elements of the plans that we have heard today, and that, in fact, T. Boone Pickens' plan for wind energy in the middle of the country fits in very well with Dr. Dagher's plan to tap offshore wind, which in turn we also need to supplement by Dr. Luft's proposals for the transportation sector and Mr. Anderson's suggestion for better planning of communities.

This is going to take the ingenuity and the innovation of everyone to achieve the goal of energy security for this country, and I for one am very appreciative of the testimony we have heard today. I told them if this were a multiple choice test, I would be checking "all of the above." And I just want to thank you, Mr. Chairman, for holding this very important hearing today.

Chairman LIEBERMAN [presiding]. Thanks very much, Senator Collins. Thanks for your inspiration which brought the hearing about. And I agree with you, this is not a problem that will be solved with a single bullet. I was impressed by that in T. Boone Pickens' testimony. He may have some favorites here, as you commented on, in terms of natural gas, but I thought in the end he was open to the various ways in which we would deal with this, if I may say so, so long as they were American—in other words, as long as they broke our dependence on foreign oil and created bridges to the zero hydrocarbon future. And then the three of you have really presented us with a series of, I think, very visionary but also practical options, which I appreciate.

I do not have any further questions.

Senator COLLINS. I just have one final comment for Dr. Dagher, and that is, give us a sense of how far away we are in your view from the technology that would make your plan feasible from an economic standpoint.

Mr. DAGHER. We are looking at about 5 to 7 years from becoming a reality in the United States. I would also like along the same lines to really recognize before we go my dear colleague, Dr. George Hart, who is sitting here. If you don't mind, George, stand up. Dr. Hart is really at the heart of developing all of these concepts, so thank you, Dr. Hart.

Senator COLLINS. Thank you. Thank you, Mr. Chairman.

Chairman LIEBERMAN. Thanks, Senator Collins, and we thank our witnesses.

We are going to leave the record of the hearing open for 15 days if Members of the Committee want to submit questions to you in writing or if you would like to add to your testimony in any way. But we thank you very much for the work you are doing and for the testimony that you offered today.

The hearing is adjourned.

[Whereupon, at 12:06 p.m., the Committee was adjourned.]

APPENDIX

Testimony of Mr. T. Boone Pickens before the Senate Homeland Security and Governmental Affairs Committee

Hearing to examine the challenges and solutions to developing energy security from domestic resources.

Tuesday, July 22, 2008
10:00 AM
106 Dirksen Senate Office Building

Chairman Lieberman, Senator Collins, and members of the Committee, thank you for holding this hearing today. Our country is in a crisis caused by imported oil, and any serious solution to help us escape from this trap will require action by the Congress to promote private investment in our electric transmission system.

We must develop and promote every available domestic energy resource to solve this crisis, and the lynchpin to addressing our escalating dependence on foreign oil is a willingness and determination to invest in and streamline development of our domestic sources of energy and our electric transmission system. Private enterprise will invest money, and will develop domestic resources and build new transmission infrastructure cheaply and efficiently, if Congress adopts clear, predictable policies.

And Senators, ladies and gentlemen, simply stated, our main energy problem begins and ends with imported oil. Seventy percent of the oil we use is imported. With current oil prices, we are getting close to exporting $700 billion a year overseas because of our addiction to imported oil. That's nearly four times the cost of the Iraqi war. We purchase it from a few friends and a lot of enemies. We are paying for the war against ourselves and we have got to stop it, some way, somehow.

And the price of oil will go up further. Over the next 10 years, you're looking at exporting $10 trillion out of this country. It will be the greatest transfer of wealth from one country to other parts of the world in the history of mankind. It is a clear and growing threat to our national security, and our national economy. It has to be stopped. We are on the verge of losing our Super Power status. It's time to quit the blame game, and look for solutions and leadership to solve the problem.

For decades, every presidential candidate has talked about making us energy independent. That hasn't happened, of course, and the hole we've dug for ourselves just keeps getting deeper. In 1945 we were exporting oil to our allies. In 1970 we were importing about 30 percent of our oil. By the 1980s it was 37 percent. In 1991 during the Gulf War, it was 42 percent. Now it's about 70 percent.

The world produces 85 million barrels of oil a day, or more than 30 billion barrels of oil a year. We haven't replaced that amount of consumption on an annualized basis since 1985. World oil production, I believe, has peaked, and the world's current oil fields are declining at the rate of 8

percent a year. The simple truth is we're never going above 85 million barrels per day of oil production.

The U.S. consumes 25 percent of the world's oil, with only 4 percent of the world's population. And what's going to happen when you're dealing with a supply plateau at 85 million barrels and increasing demand as the Chinese, Indians, and rest of the underdeveloped countries around the world continue to use more and more oil?

I have a plan to fix this problem. I've stress tested it with government and business leaders across the U.S. in recent months. No one has found any major flaws in it. That said, if there's a better plan out there, it's time to hear it. The time for action is now.

Worldwide 70 percent of the 85 million barrels a day is used for transportation. To replace foreign oil, we need a major energy source that works for transportation. The domestic energy resources we have are oil, coal, natural gas, wind, solar, bio-fuels, hydroelectric and nuclear.

Natural gas and bio-fuels are the only fuels on the list that work to replace foreign oil for transportation. It's my belief that bio-fuels, while helpful, will not be the total solution.

So we have domestic natural gas as the only near term replacement for foreign oil. Natural gas is clean, abundant, affordable and, again, domestic. We have approximately 80 years supply of natural gas available to us from sources in North America. Domestic natural gas reserves are twice that of petroleum. And new discoveries of natural gas and ongoing development of renewable biogas are continually adding to existing reserves., In fact, 98% of the natural gas consumed in the United States is produced in the US and Canada.

Natural gas is the second largest energy resource in the country. When you look at the pie chart of power generation in the United States, you have 50 percent coal, 22 percent natural gas, 20 percent nuclear and 8 percent hydro and renewables.

Let me first say that we need all the sources of electricity that we can lay our hands on. The Energy Information Administration forecasts that electricity consumption will increase by at least 40 percent by 2030, just to keep pace with the energy needs of a growing population and a growing economy. While I am betting that wind will be a big part of this growth, there is no doubt that coal, nuclear, natural gas and other forms of renewable energy will be needed to slake our nation's growing thirst for energy. My plan will not disadvantage existing fuels, nor displace employees or companies that make their living in the provision of those fuels.

If we take the natural gas we would be using for electrical generation to meet new demand and replacement of existing plants and move it to transportation, we can replace 38 percent of our foreign oil imports. And that, sports fans, is a real number.

Using natural gas for transportation is not a new idea. While there are only 150,000 vehicles running on natural gas in the U.S., there are nearly 8 million automobiles worldwide and that number is growing rapidly. There are numerous manufacturers of natural gas vehicles for the

world market, including Ford, Honda and General Motors. We're getting beat by the French in nuclear power, and by the world in natural gas vehicles. We should be leaders, not laggards.

I know that we can do this because we've done it before. President Eisenhower led us to build an extraordinary interstate highway system. President Kennedy took us to the moon. And President Reagan led us to win the cold war.

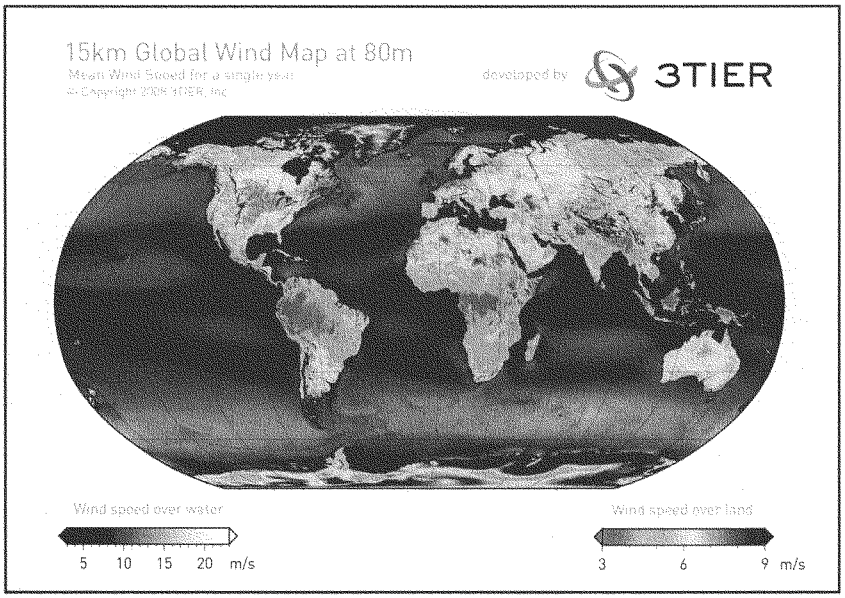
President Reagan led the United States to defeat communism without firing a single shot or sacrificing a single American life by exploiting the economic weakness of the communist system, and overwhelming them with military spending. Today, the Russian gas monopoly, Gazprom, is proposing to build natural gas fueling stations all over Europe, while we continue to import foreign oil. We should ask ourselves "Are we going in the direction of greater economic security in our energy policy?"

If you could lower your foreign oil imports by 38 percent, you are reducing the amount of money you're exporting by 38 percent. Reduce $700 billion in foreign oil purchases by 38 percent and you'll see an annual savings of nearly $300 billion every year. $300 billion more would be staying inside our country instead of going to other countries overseas.

Nothing can reduce your imports better than this and you work with energy supplies right here.

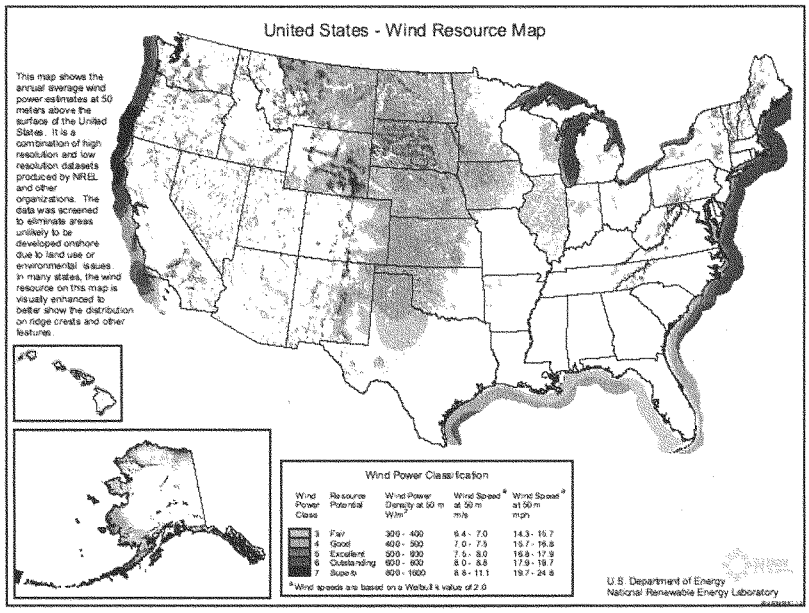
But if we use all of that natural gas for transportation, how do we replace it in the nation's electrical supply?

The Sweetwater, Texas, wind complex is the model. If you take the total Sweetwater complex it will soon be producing 2,000 megawatts. The Shell Oil Company and Energy Future Holdings are getting ready to do another project just north of Sweetwater, and that's 3,000 megawatts. My company, Mesa Power, just put under contract with GE the largest single turbine order that has ever been given. The first phase of the Mesa Pampa Wind Project will be capable of generating 1,000 megawatts of electricity, enough for 300,000 average U.S. homes. When we complete the entire project, it will have the capacity to generate some 4000 megawatts and will have cost close to $10 billion.

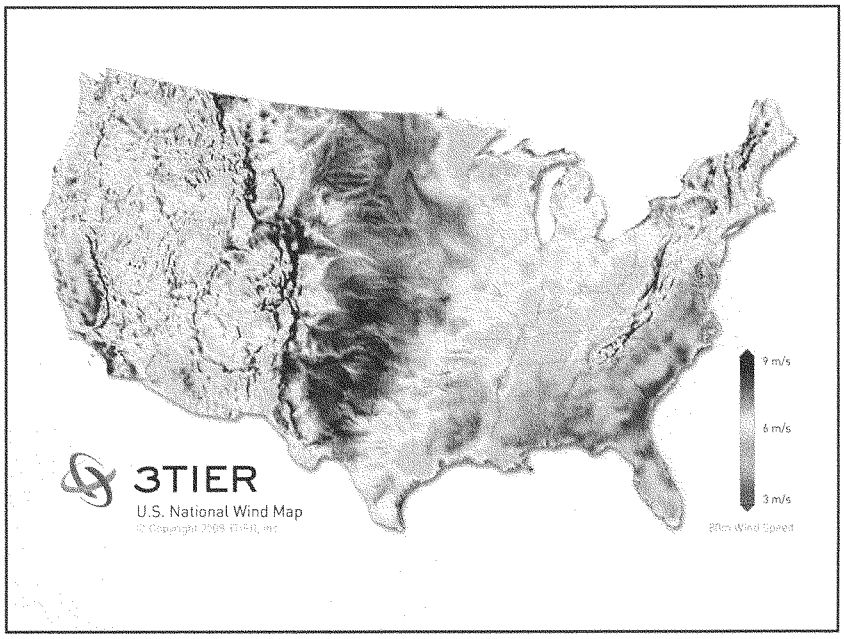


As you can see from the map above, we have some of the best wind resources in the world. It's time we got serious about using it.

The US wind corridor runs from Sweetwater to Pampa and Goodland, to Kansas, and Hastings, Nebraska and right up the line to Canada. The Department of Energy in April of this year showed that we could develop 20 percent of our electricity generation from wind using wind resources in the heartland of the United States.



The map below shows the same wind corridor with slightly better resolution.



Now, if you take wind power and use it to replace natural gas for electricity generation, you can release the natural gas to transportation. One million cubic feet (MCF) of natural gas equals 8 gallons of gasoline. At $4 dollars a gallon for gasoline, that means an MCF of natural gas is worth $32 dollars. ***And natural gas is selling today around $12 dollars an MCF.***

We don't buy all of our oil from our enemies. We do have some friends – Canada and a few others. But most of the money that the world pays for oil goes into the hands of countries that are not our reliable allies. And some of that money is used right back against us in the war on terror. And so, we are funding the people who are trying to wreak havoc on this country.

The good news is we can use alternatives to address this problem. I am 100 percent for all alternatives. We cannot limit ourselves to any single solution, whether it is nuclear power, drilling for more domestic oil and gas, or renewable energy. It is clear that renewable energy sources are an essential national security strategy. But in order for renewables to replace a meaningful amount of our imported oil, we need a national electricity transmission system stretching both east and west to carry this electricity, be it generated from wind, solar, biomass or other alternatives.

I have always believed that an idea has to be simple to be worth investing in. That is why I am building the world's largest wind farm. There is good wind in the area where I live in Roberts

County in the Texas Panhandle, and I have the ability to transmit the electricity to markets in Texas that will pay for it. Good wind and transmission are the keys to my project.

I think that most of the people in the wind generation business will tell you those two elements are key to every wind project. That is because, as can be seen from the wind resource maps above, the large, flat, open areas with adequate wind are located a long way from where electricity is needed on the east and west coasts. Since we can't do much about where nature has put the wind, we have to do something about transmission to move the electricity to market.

Unfortunately, the large, flat, open areas with adequate wind do not already have transmission service because there has been no reason to provide transmission service to those areas, so we are looking at a need for green field transmission projects. The Department of Energy map below has identified the scale of transmission projects that will be required to move electricity generated from our wind resource heartland to the load centers that need it.

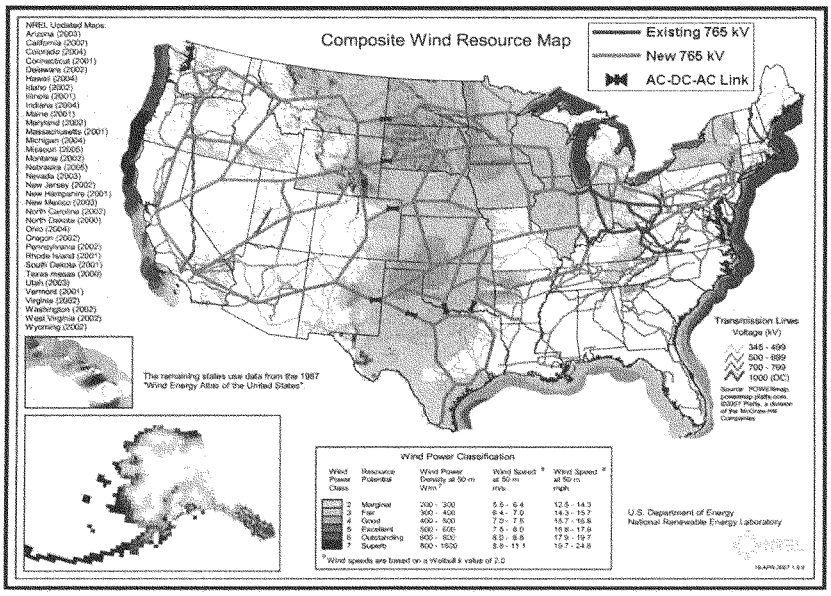


Exhibit 1: Conceptual 765 kV backbone system for wind resource integration (edited by AEP).

Greenfield transmission projects all face the same obstacles--siting, use of federal lands, permitting, equitable allocation and recovery of costs, equitable allocation of capacity, and availability of financing.

As the Western Governors Association has said, "[W]hile there are many incentives that can stimulate renewable energy growth, perhaps the most critical obstacle renewable energy faces is the availability of transmission. In many cases high quality renewable resources are in remote areas where transmission does not exist, and we all know building new transmission can be both a costly and lengthy, if not controversial, process."

Senator Reid's bill, S. 2076, which would provide for the identification of National Renewable Energy Zones, will definitely help move the process forward, but I would like to explain to this Committee what I see as the issues through the eyes of a wind project developer who has had to deal with each of these issues.

There is a sequencing problem that is circular—transmission won't be built unless there is generation capacity to be carried, and generation won't be built unless there is transmission. Furthermore, long distance transmission is only economic if it is built to high capacity, which means that there must be a large amount of generation capacity in one place.

I happened to be lucky with my project, because I was already planning a water project that required a pipeline running in the same direction that I needed transmission for my wind project. The water project pipeline right of way eliminated the siting and permitting issues, but I still have to face the financing, and cost recovery issues.

As you may know, Texas has taken a leadership role in encouraging the development of wind generation. The Texas Legislature has adopted a renewable portfolio standard, which has encouraged development of wind projects in Texas, and has directed the Texas Public Utility Commission to identify competitive renewable energy zones (CREZ)—areas that are well suited to development of renewable energy production, and to adopt policies that will make transmission available to those zones.

However, the Texas CREZ process began in 2005, and is expected to be completed in 2013. I am eighty years old, and I don't have time to wait for the process to be completed, and neither does this country. I am building my own transmission line, which will ultimately travel 250 miles in Texas from the top of the Panhandle to near the Dallas/Fort Worth area, and I will have to pay for this transmission line myself. Not very many wind developers are in a position to do this.

I expect to sell my power in the Texas ERCOT market where prices are set by competition among power generators. As a result, I will not be able to simply increase the price of my power to cover transmission; instead, my profits will be reduced by my transmission line costs. This is a penalty that I am willing to pay in order to get my electricity to market first, but it is not a burden that most developers can bear. It requires scale and financial capacity. That is how I came to build the world's largest wind farm. It is the only way to pay for the transmission capacity as a private line, and it is only feasible within Texas. If you want to do it on a national scale, where the transmission line distances will be much longer, and utility regulations are different, Congress must act.

As I said earlier, I believe that the United States has the opportunity to build renewable electricity capacity to serve a substantial part of our needs for energy. By doing so, we will

increase our energy security, improve our environment, revitalize the heartland of the United States, reduce the demand for natural gas to be used as fuel for generation, reduce the production of greenhouse gases, and reduce the demand for water to be used in thermal generation.

In order to secure these benefits, the issues that I identified above must be addressed. Let me take a moment to explain each of them.

Siting Authority. As a land owner myself, I understand concerns that landowners have about having their property taken for public use. Quite properly, our Constitution provides protection for landowners from arbitrary takings. However, for more than 150 years, we have recognized that private companies transporting the common necessities of life, food, water, fuel and electricity, to cities and towns are serving the public interest because life in the cities would not be possible without those necessities. As a result, private companies, such as Mesa Power, have been permitted to use the power of eminent domain, subject to oversight by public authorities and the courts, to obtain rights of way for transportation corridors.

This system worked well for many years, but the large distances between the best sites for renewable power and the places where that power is needed have presented new challenges. The state public authorities that oversee the use of eminent domain by private companies are required to consider the benefits of the project to the citizens of their states. They often have indicated that they do not have the authority to consider the benefits to citizens of the United States who are not residents of their states in deciding whether a particular transmission line should be permitted to be located through the power of eminent domain.

No project sponsor likes to use eminent domain powers. It is slow, cumbersome, expensive and unpredictable. Negotiated easements that result in a landowner willingly permitting the use of the land are very desirable. However, a transmission line with a gap in it, no matter how small, is useless. Any single landowner along a transmission route can prevent the entire project from being constructed, no matter how important the transmission project, unless the transmission provider has the power of eminent domain.

Where state utility commissions are limited by state law to considering benefits to citizens of their state, eminent domain power may not be available to transmission developers wishing to cross the state without providing transmission service to local generators or local electricity users. This problem was recognized in the Energy Policy Act of 2005 (EPAct 2005), but the provisions of that act, which added Section 216 of the Federal Power Act, need to be extended. Section 216 currently requires that the Secretary of the Department of Energy conduct a study and issue a report designating corridors as National Interest Electric Transmission Corridors every three years. After the designation, a transmission service provider can seek siting approval from a state commission, and if the approval is not received within one year, the provider can then seek siting approval from the Federal Energy Regulatory Commission (FERC). This introduces a potential delay of over four years before the FERC transmission approval process can even begin. In addition, there is not agreement that the language of Section 216 authorizes a finding by the Secretary of Energy that transmission is "constrained" if there is a proposed project, but no available transmission at all. Congress needs to address these issues by amending Section 216 to direct the Secretary to make designations of National Interest Electric Transmission Corridors, outside the three year cycle provided by Section 216, upon request from

a transmission service provider who can show that a renewable project developer has requested service and a load serving entity is willing to contract to purchase power from the renewable project developer. Congress also needs to provide the FERC exclusive jurisdiction to site new transmission for a renewable energy project in the specific case where a developer has contracted to build, and a load has contracted to buy the energy from, a new renewable energy resource.

Federal Lands. Most long transmission lines in the west will cross federal lands. Again, while EPAct 2005 recognized the issue, and provided a process to address the issue, the process for approval should be streamlined. Either designation of a national interest electric transmission corridor by the Secretary of Energy or specific siting approval by the FERC should be sufficient to grant approval by the United States for use of any federal lands crossed by the proposed transmission line. (EPAct 2005 excluded lands included within the National Park System, the National Wildlife Refuge System, the National Wild and Scenic Rivers System, the National Trails System, the National Wilderness Preservation System, or a National Monument from its scope, and those exclusions should be continued.). Any affected federal agency could appear in the FERC proceeding to present any concerns regarding the use of federal lands included in the proposed route for the transmission line.

Federal Permitting. Every transmission line involves multiple approvals from the United States and its agencies and departments. While it is possible with enough time and patience to gather the necessary permits, it introduces unnecessary delays into the process. Again, EPAct 2005 addressed the issue, but the process can be further streamlined. While EPAct 2005 did authorize the DOE to take the lead in coordinating federal permitting, and required other agencies and departments to enter into a memorandum of understanding with DOE regarding permitting projects, I believe that DOE should be authorized to issue the required permits directly after the transmission service provider meets the requirements for those permits in the judgment of DOE.

Equitable Cost Allocation and Recovery. As I said earlier, a transmission line with a gap in it is worthless. Put another way, there is no useful way to build a transmission line in phases. It either is or it isn't. As a result, the costs are all incurred at once before it is available for use. Generation, on the other hand, can be built over time, and may have to be built as wind turbines become available. That means that the first wind turbines on a transmission line may not be able to bear the entire cost of the transmission line until more of the transmission line capacity is in use.

In Texas, we have concluded that transmission service to renewable energy production areas is socially desirable, and our legislature has directed our public utility commission to develop a plan, the CREZ plan that I mentioned earlier, to pay for extending transmission lines to serve areas where renewable resources are available to generate electricity. The cost of those lines will be paid by the ratepayers throughout ERCOT, because all of them benefit. In Texas, we have a very large market for electricity, the ERCOT market, so that several billion dollars of costs can be spread across the entire market without creating a problem for electric rates. In much of the rest of the country that is not true. It is a particular problem where many interconnected systems would benefit from new long distance transmission to serve renewable generation projects, but one utility or group of rate payers is expected to bear the entire cost.

Once again, Congress addressed the issue in EPAct 2005, but the FERC needs to be directed to spread the costs more widely, across multiple states if necessary, to reflect the benefits that are gained from the transmission project in terms of congestion relief, and other benefits. I propose that the FERC should be directed to allocate the costs of a new transmission line constructed under a special renewable resource NIETC designation that the FERC has sited to all load that benefits from the access to the energy transmitted over the line.

These investments will eventually find their way into utility bills that customers pay and, as Governor Freudenthal of Wyoming has said, we should be square with utility consumers about the cost of these transmission investments. There are, however, costs associated with inaction. Those costs are real and in the long term could prove to be much higher than the costs of the transmission investments I have discussed today

Equitable Allocation of Capacity. If I put several billion dollars at risk, which I expect to do with my project, it does not strike me as fair that someone else can show up after everything is built, and all of the risks have been taken, and ask for and receive the right to use the transmission line that I paid for and force me to curtail transmission of my own electricity to permit them to use the transmission line. If you are going to encourage people to take entrepreneurial risk, you cannot expect them to do so if they can receive the same benefits by sitting back and waiting for someone else to take all the risk. Open access is fine for transmission lines that have already been in service for many years and their costs recovered, but there must be a process that encourages renewable generation developers to put up risk capital in return for preferred access rights to transmission capacity.

Financial Incentives. I think that I may be unique both in being willing to take the risks that I am taking in developing my wind project, and in having the capital to do so. Most of the other wind developers, even the other developers who are willing to develop on utility scale, are not willing to take the sorts of risks that I am facing. I would not be willing to do it if I was not a believer that Congress will do the right thing in the end. Wind and other renewable energy projects need production tax credits. For projects like the one that I am building, we need predictable policies regarding the credits for the long period that it takes to get everything put together. My project, even with the favorable regulatory climate for wind in Texas, will take seven or eight years to complete. If we decide to build more generation capacity to supply other parts of the country, it may even take longer from start to finish. We need to know, when we start, what economic incentives will be in place when we get to the finish line. Otherwise, developers have to use very conservative assumptions about project economics, and many projects just won't get built. We also need targeted incentives for transmission lines, such as the loan guarantee program for rural renewable transmission lines that was proposed by the Senate in its version of the Farm Bill. Long distance transmission projects for renewable energy should qualify for an investment tax credit as well. When climate change legislation is considered again, if a cap and trade program is the mechanism, renewable energy projects should receive an allocation of credits based upon production. Those credits can be sold to help underwrite the cost of transmission lines to serve remote projects.

If we do these things, our country will benefit. We will see reduced demand for imported oil, cleaner air, a reduction in the price of natural gas, savings in demand for water to cool thermal

generation, revitalization of the rural heartland in the central United States, and natural gas used for higher, better purposes than electricity generation.

We can fix these problems over time if we move a meaningful amount of our power needs to alternatives. There are no enemies, no competitors, nothing in domestic alternatives.

I have a mission ladies and gentlemen. That mission is to try to explain what I've just explained here. And no matter how many times I explain it nobody argues with me about it. Which is interesting because I wish somebody would jump up and say you're wrong and let me show you where you're wrong. And nobody does that. Everybody says, well, that sounds like a good idea.

So, I don't know whether it's a good idea or whether they don't understand.

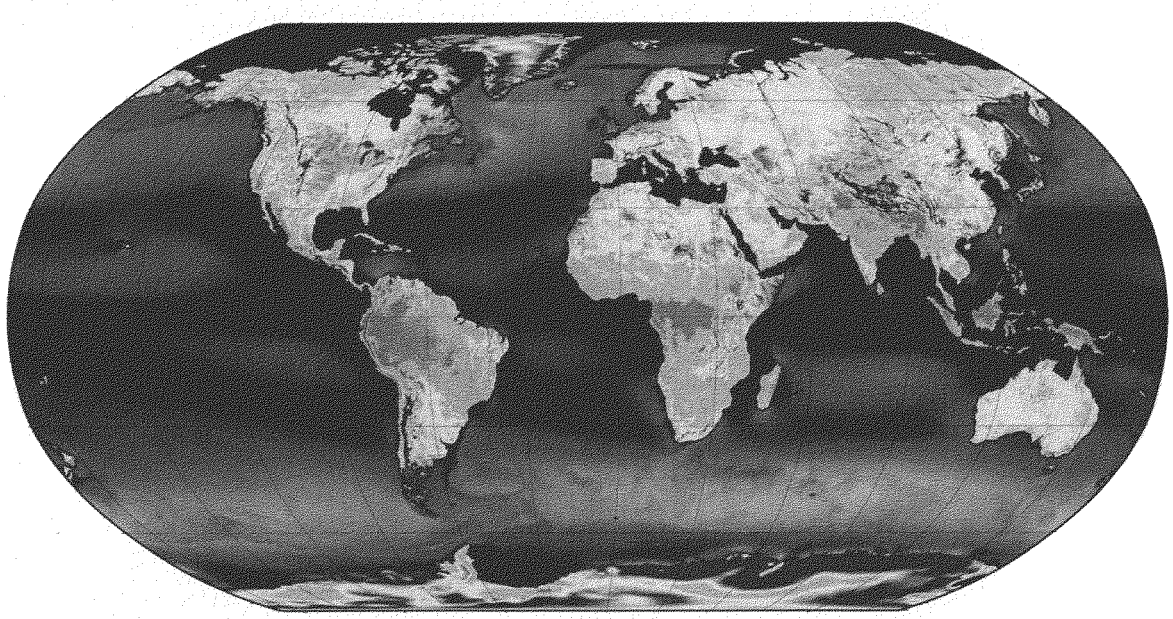
Again, thank you Mr. Chairman for holding this hearing today. If we don't solve the energy problems we are facing, the hole we are in will continue to grow and swallow more and more of our scarce resources and will overwhelm us as a nation.

I am happy to answer any questions you may have.

15km Global Wind Map at 80m

Mean Wind Speed for a single year

developed by 3TIER

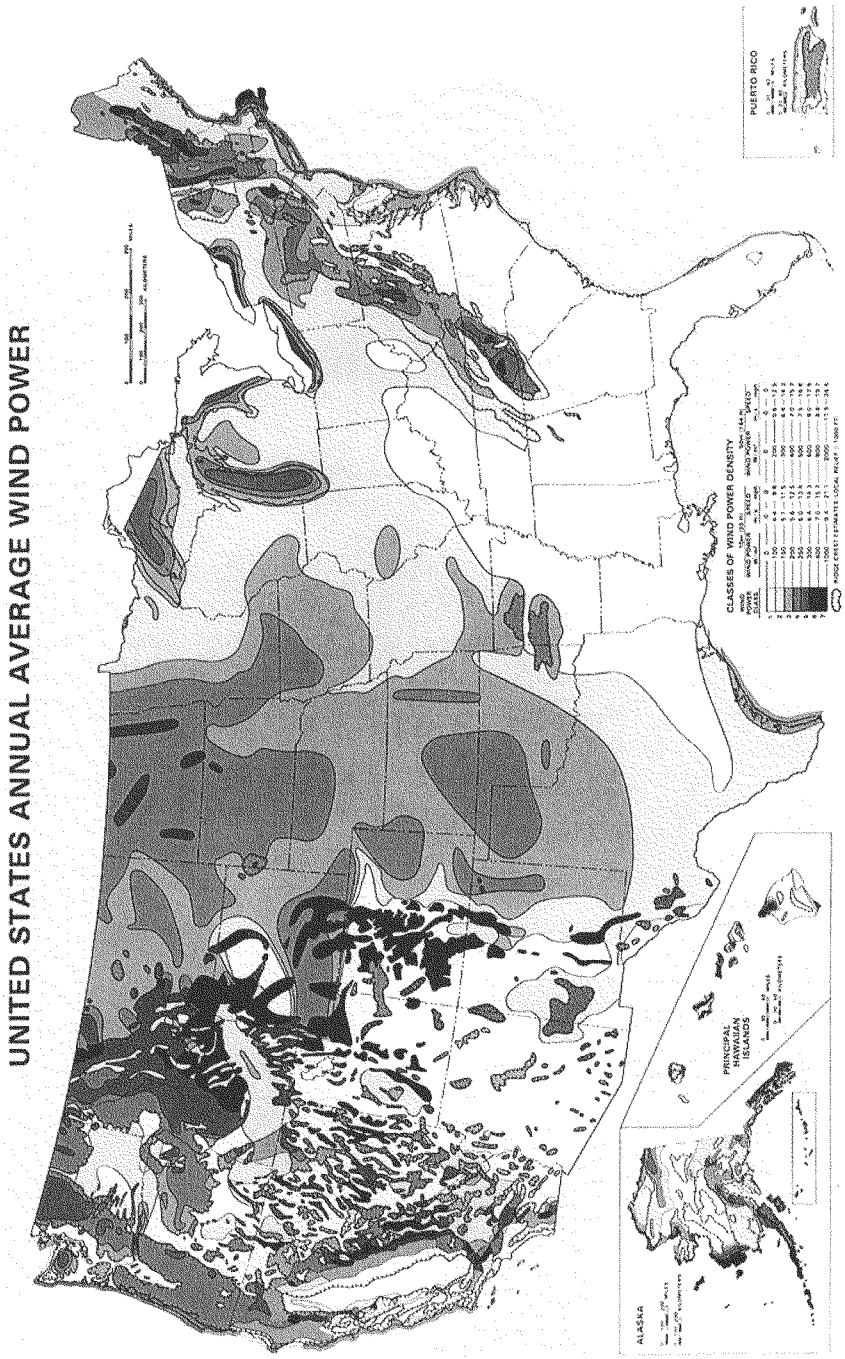


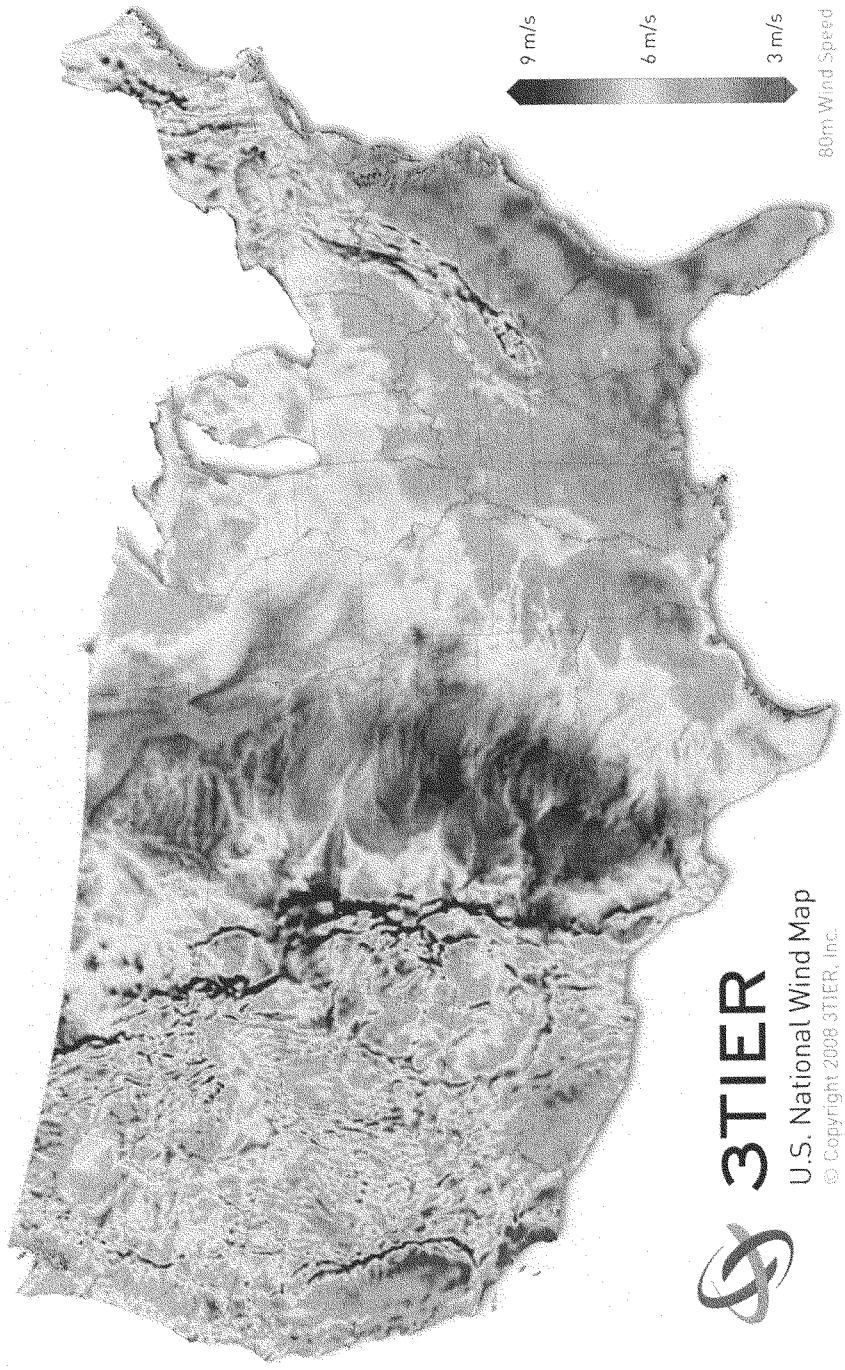
Wind speed over water

5 10 15 20 m/s

Wind speed over land

3 6 9 m/s


UNITED STATES ANNUAL AVERAGE WIND POWER
CLASSES OF WIND POWER DENSITY
ALASKA
PRINCIPAL HAWAIIAN ISLANDS
PUERTO RICO


9 m/s
6 m/s
3 m/s
80m Wind Speed
3TIER
U.S. National Wind Map
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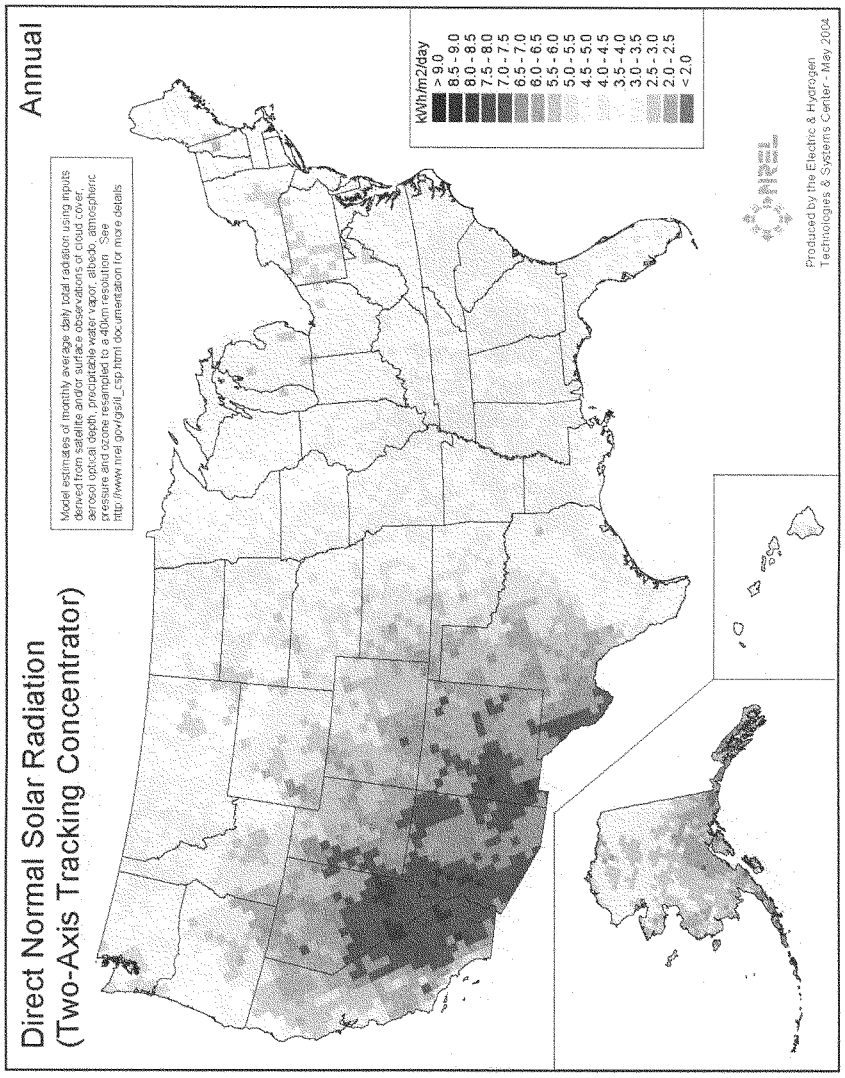
Direct Normal Solar Radiation
(Two-Axis Tracking Concentrator)
Annual
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/cfs_csp.html documentation for more details
kWh/m2/day
> 9.0
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
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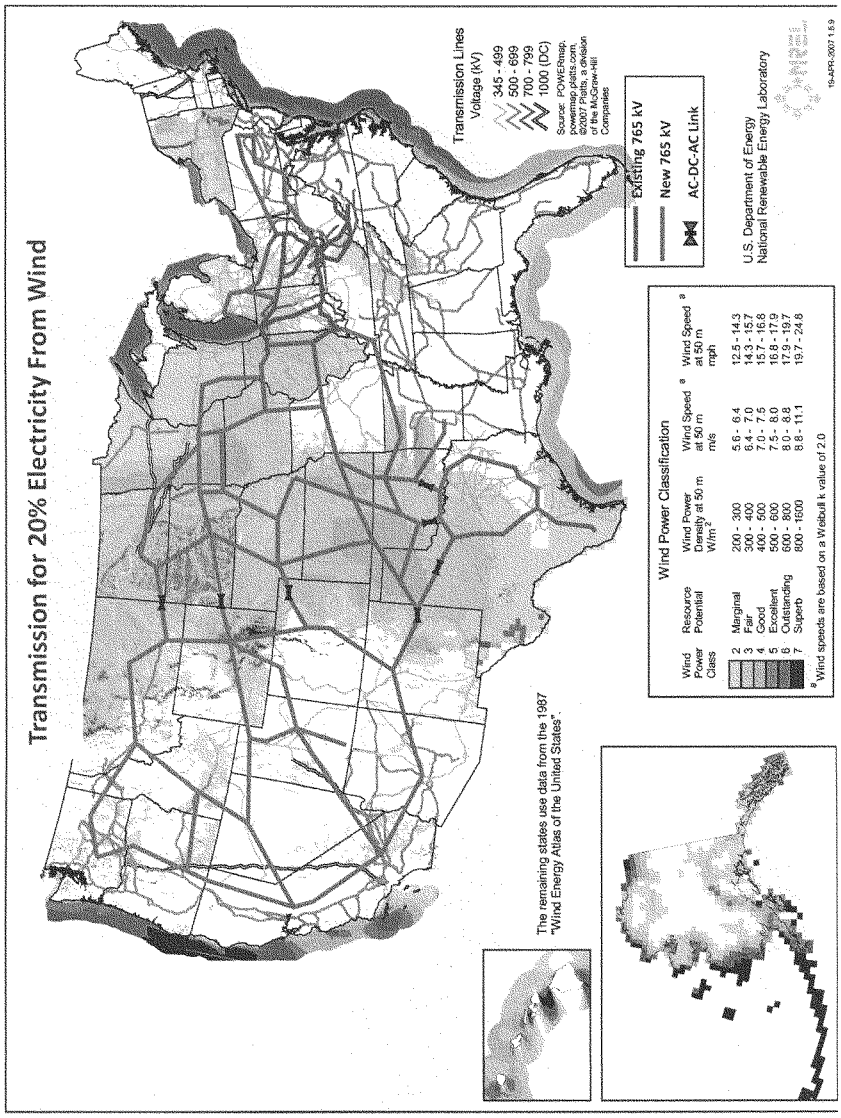
Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004


Transmission for 20% Electricity From Wind
Transmission Lines
Voltage (kV)
345 - 499
500 - 699
700 - 799
1000 (DC)
Source: POWERmap, powermap.asp.com, ©2007 Platts, a division of the McGraw-Hill Companies
Existing 765 kV
New 765 kV
AC-DC-AC Link
Wind Power Classification
Wind Power Class
Resource Potential
Wind Power Density at 50 m W/m²
Wind Speed [a] at 50 m m/s
Wind Speed [a] at 50 m mph
2 Marginal 200 - 300 5.6 - 6.4 12.5 - 14.3
3 Fair 300 - 400 6.4 - 7.0 14.3 - 15.7
4 Good 400 - 500 7.0 - 7.5 15.7 - 16.8
5 Excellent 500 - 600 7.5 - 8.0 16.8 - 17.9
6 Outstanding 600 - 800 8.0 - 8.8 17.9 - 19.7
7 Superb 800 - 1600 8.8 - 11.1 19.7 - 24.8
[a] Wind speeds are based on a Weibull k value of 2.0
The remaining states use data from the 1987 "Wind Energy Atlas of the United States".
U.S. Department of Energy
National Renewable Energy Laboratory
19-APR-2007 1.6.9

TESTIMONY BY DR. GAL LUFT
EXECUTIVE DIRECTOR
INSTITUTE FOR THE ANALYSIS OF GLOBAL SECURITY (IAGS)
AND CO-FOUNDER, SET AMERICA FREE COALITION

Presented before

SENATE COMMITTEE ON HOMRLAND SECURITY AND GOVERNMENTAL AFFAIRS

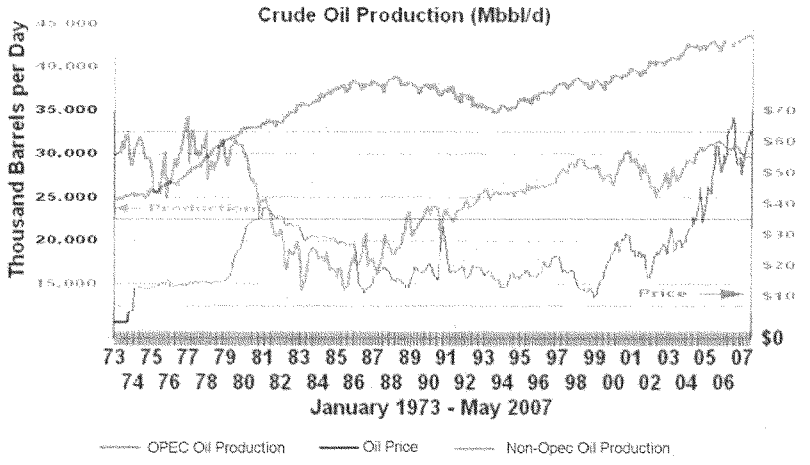
Breaking oil's monopoly in the transportation sector

July 22, 2008

Mr. Chairman, members of the committee, ten years ago, Osama bin Laden set a target price for oil at $144 a barrel. At the time, crude oil prices stood at $12 a barrel and his figure, aimed to compensate the Muslims for what he called "the biggest theft in the history of the world," sounded delusional. Four years ago, just prior to the U.S. elections, when oil prices stood at $38, bin Laden explained his economic warfare strategy: "We bled Russia for ten years until it went bankrupt and forced to withdraw in defeat. We are continuing the same policy to make America bleed profusely to the point of bankruptcy."
Reputable energy analysis outfits held a completely opposite view on the future of oil. A 2005 report by Cambridge Energy Research Associates (CERA) held that by 2010 global oil supply would rise by as much as 16 million barrels per day (mbd). "We expect supply to outstrip demand growth in the next few years, which would take the pressure off prices around 2007-2008," wrote the report's authors. As we know, this never happened. World oil production has been flat since 2005 and $144 might soon become a fond memory.
Today, with oil prices above bin Laden's stated goal, his economic warfare strategy seems like a resounding success. At a time al-Qaeda is on the run, $144 oil is a major morale booster and the best birthday present for its 20th anniversary next month. There is no need to elaborate on the implications of such a victory in terms of loss of U.S. prestige and our ability to prevail in the Long War of the 21-Century. Furthermore, at current price level, the U.S. will spend over $600 billion on imported oil this year, more than our defense budget, and much of that money will flow into the coffers of those who wish us ill. It has long been clear that our oil dependence forces us to pay for both sides of the war on terrorism. In light of this year's figures, we are paying the other side more than we invest in our own defense.

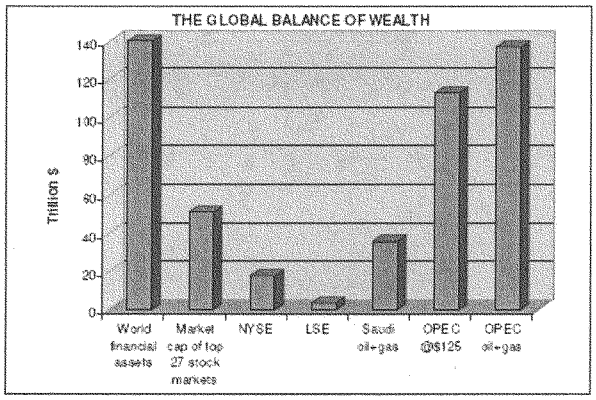
A cartel married to a monopoly

In order to chart the road to energy security, we must first understand why we are where we are. There are many reasons for the current oil crisis. Strong demand in developing Asia, speculation, geological decline and malevolent disruptions have all contributed their share. But by far, the main culprit is OPEC's reluctance to ramp up production. The cartel owns 78 percent of the world's proven reserves and produces about 40 percent of its oil production. In 1973, OPEC produced 30mbd, while non-OPEC produced 25mbd. Today, OPEC produces 32mbd while non-OPEC production is close to 45mbd. In other words, OPEC today produces almost as much oil as it did 35 years ago while the world global demand for oil has nearly doubled.



Source: WTRG Economics

Clearly it is not in OPEC's interest to provide relief to the struggling global economy. The cartel enjoys a vertical monopoly of the world vehicle fuel supply, and it is currently at the receiving end of the biggest transfer of wealth in human history. To understand the magnitude of the forces in play it is instructive to visualize the scale of OPEC's wealth in comparison to that of consuming countries: imagine that OPEC members are corporations and a barrel of oil is a share. At $125 oil, OPEC's market capitalization based on its proven reserves stands today at roughly $137 trillion. This is roughly equivalent to the value of the world's total financial assets--stocks, bonds, other equities, government and corporate debt and bank deposits--or roughly three times the market capitalization of all the companies traded in the world's top 27 stock markets. Such monumental wealth potential will translate into unprecedented buying power for the oil countries. For demonstration sake, at $200 oil OPEC could potentially buy Bank of America in one month worth of production, Apple Computers in a week and General Motors in just 3 days. It would take less than two years of production for OPEC to own a 20 percent stake (which essentially ensures a voting block in most corporations) in every S&P 500 company.



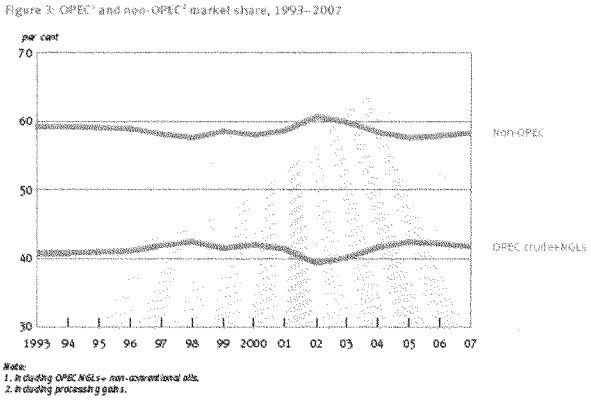
Source: Institute for the Analysis of Global Security

OPEC's reluctance to increase production is today the main factor contributing to global poverty. While we in the U.S., which enjoys a per capita income of over $40,000 a year, are feeling the sharp pinch of high oil prices, we should all consider the impact of these prices on the world's poor. People throughout the world who live on $2 a day are being now looted by OPEC price fixing. This has profound implications for global security, driving regional unrest, increasing poverty, and nipping in the bud progress towards democracy.

Beware of perpetuation of the petroleum standard

The unique strategic importance of oil to the modern economy—beyond that of any other commodity today—stems from the fact that the global economy's very enabler, the transportation sector, is utterly dependent on it, with 220 million cars and trucks in the United States alone (today, contrary to popular belief, only 2 percent of U.S. electricity is generated from oil, and conversely only about 2 percent of U.S. oil demand is due to electricity generation.) With 97 percent of U.S. transportation energy based on petroleum, oil is the lifeblood of America's economy. America is poor in oil relative to its need. It consumes one of every four gallons in the world but has barely 3 percent of the world's proven reserves of conventional oil. The United States now imports over 60 percent of its oil, more than twice the ratio of imports before the 1973–74 Arab oil embargo.

Neither efforts to expand petroleum supply nor those to crimp petroleum demand through increased CAFE standards will be enough to reduce America's strategic vulnerability anytime soon. On the contrary, as the graph from OPEC's own statistics shows, when we drill more, they drill less. Such policies at best buy us a few more years of complacency, while ensuring a much worse dependence down the road when America's conventional oil reserves are even more depleted.



Source: OPEC

Rather than focusing on solutions that perpetuate the petroleum standard, we should invest in transformational policies that aim to diminish the strategic importance of oil by breaking its monopoly in transportation.

Real energy security can be achieved only through fuel choice and competition. That competition cannot take place as long as we continue to put 16 million new cars that run only on petroleum on our roads every year, each with an average street life of 16.8 years -- thereby locking ourselves into decades more of petroleum dependence.

Barring a significant change, a senator elected in 2008 will witness the introduction of 102 million gasoline only cars during his or her 6-year term. I cannot think about something more detrimental to America's security than Congress letting this happen.

Number of gasoline only cars introduced during the term of an official elected in 2008

Congressman	**32 million**
President	**68 million**
Senator	**102 million**

When in a hole, stop digging

The first thing we must do is to ensure that the cars rolling onto America's roads are platforms on which fuels can compete. For a cost of less than $100 extra as compared to a gasoline-only vehicle, automakers can make virtually any car a flex fuel vehicle, capable of running on any combination of gasoline and a variety of alcohols such as ethanol and methanol, made from a variety of feedstocks, from agricultural material, to waste, to coal. (Alcohol does not just mean ethanol, and ethanol does not just mean corn.) Flex fuel vehicles let consumers and the market choose the winning fuels and feedstocks based on

economics. In Brazil, where ethanol is widely used, the share of flex fuel vehicles in new car sales rose from 4 percent to 90 percent in under five years. These cars are manufactured by the same automakers that sell to the U.S. market and entail no size, power, or safety compromise by consumers. The proliferation of flex fuel vehicles in Brazil has driven fuel competition at the pump to the point where the Brazilian oil industry has had to keep gasoline prices sufficiently low to compete with ethanol in order not to lose more market share, so low that it actually just received a government subsidy to do so. Indeed, in Brazil, ethanol will become this year an alternative fuel.

Expanding U.S. fuel choice to include biofuels imported from developing countries has significant geopolitical benefits at a time when U.S. global standing is eroding. Sugar, from which ethanol can be cheaply and efficiently produced, is now grown in one hundred countries, many of which are poor and on the receiving end of U.S. development aid. Encouraging these countries to increase their output and become fuel suppliers, opening our fuel market to them by removing the protectionist 54 cent a gallon ethanol tariff, could have far-reaching implications for their economic development. By creating economic interdependence with biomass-producing countries in Africa, Asia, and the Western Hemisphere, the United States can strengthen its position in the developing world and provide significant help in reducing poverty.

At this point, the fallacy that increased use of biofuels in general, and corn ethanol in particular, is driving world hunger must be addressed. The primary drivers of price increases for food commodities spanning the spectrum from fish to rice (neither of which are used to make fuel) and beyond are the massive increases in oil prices -- raising the cost of distribution, labor, packaging and so forth; commodity speculation driven by a weak dollar and increased calorie demand from hundreds of millions of people in China and India who have risen out of poverty and bare subsistence. Further, despite corn ethanol production, the U.S. corn food and feed product has increased 34 percent over the last five years, and U.S. food exports overall have increased 23 percent on the year. America is clearly doing its share to feed the world.

Furthermore, the International Energy Agency has reiterated that biofuels are key to keeping the lid on an overheated transportation fuel market. According to Merrill Lynch, without the increase in biofuels production, oil prices would have been 15 percent higher, which at current oil prices translates into a savings of over $80 billion a year to the U.S. economy. The much derided biofuels program which has facilitated this $80 billion saving, costs the taxpayer $4 billion a year. By any reasonable standard it is a far better deal to send money to America's farmers than to various petro-dictators.

Methanol

True flex fuel cars should also accommodate another important fuel called methanol. China has embraced this alcohol fuel. Several provinces in China already blend their gasoline with methanol and scores of methanol plants are currently under construction there. The Chinese auto industry has already begun to produce flex-fuel models that can run on methanol. Methanol packs less energy per gallon and is more corrosive than ethanol. But it is cheaper and far easier to produce in bulk. While ethanol can be made only from

agricultural products such as corn and sugar cane, methanol can be made from agricultural waste, natural gas, coal, industrial garbage and even recycled carbon dioxide captured from power stations' smokestacks -- an elegant way to reduce greenhouse gas emissions.

Electricity

Since we hardly generate any electricity from oil, using electricity as a transportation fuel enables the full spectrum of electricity sources to compete with petroleum. Plug in hybrid electric vehicles (PHEVs) can reach oil economy levels of 100 miles per gallon of gasoline without compromising the size, safety, or power of a vehicle. If a PHEV is also a flexible-fuel vehicle powered by 85 percent alcohol and 15 percent gasoline, oil economy could reach over *500 miles per gallon* of gasoline. Ideally, plug-in hybrids would be charged at night in home or apartment garages, when electric utilities have significant reserve capacity. The Department of Energy estimates that over 70 percent of the U.S. vehicle market could shift to plug-in hybrids without needing to install additional baseload electricity-generating capacity. In addition, the U.S. is the world's biggest potential market for electric cars which can be sold as second or third family car. Thirty one percent of America's households own two cars and additional 35% own three or more vehicles. There are over 75 million households in the US that own more than one vehicle and that can potentially replace one or more gasoline only cars with cars powered with made-in-America electricity.

A nationwide deployment of flex-fuel cars, flex fuel plug-in hybrids, and alternative fuels could take place within two decades. But such a transformation will not occur by itself. Every year that passes without Congressional action to ensure that new cars sold in America are flex fuel vehicles is another year in which 16 million gasoline-only cars start their 17-year life on U.S. roads, further binding us to foreign oil. On the grounds of national security and in the interest of stemming the hemorrhaging of our economy, Congress should take swift action to require that new vehicles sold in the United States are flexible fuel vehicles through an Open Fuel Standard. Such an Open Fuel Standard would level the playing field and promote free competition among diverse energy suppliers. A few years ago Congress passed an open standard for television mandating that as of February 2009 every television sold in the U.S. must be digital enabled. Further, Congress allocated coupons in the amount of $80 per household to allow Americans to convert their analog TV to digital transmission. One would hope we consider our transportation sector at least as strategic as television watching.

I realize that many are opposed to any government interference in the market. Indeed, in a perfect world, government would not need to intervene in the energy market, but in a time of war, the United States is taking an unacceptable risk by leaving the problem to be solved by the invisible hand. This is especially true since the energy market is anything but free. It is manipulated by a cartel, heavily rigged in favor of the status quo, and, as the case of the ethanol tariff shows, riddled with protectionism.

Choosing not to embrace an Open Fuel Standard, is choosing to preserve oil's monopoly in the transportation sector, and with it OPEC's growing stranglehold over the global economy and in essence guaranteeing continuous economic and strategic decline.

Statement of Geoffrey Anderson, President and CEO of Smart Growth America

Before the Senate Homeland Security and Governmental Affairs Committee
July 22, 2008

Mr. Chairman, Madam Chairman and members of the Committee, thank you for holding a hearing on such an important set of issues.

My name is Geoff Anderson and I am the President of Smart Growth America. Smart Growth America is a nationwide coalition supporting communities looking for a better way to grow: one that protects farmland and open space, revitalizes neighborhoods, keeps housing affordable, and provides more transportation options. Our more than 100 coalition members include the leading national organizations focusing on affordable housing, environmental protection, social equity, and transportation policy along with other issues as well as state, regional, and local organizations working on behalf of their communities.

I was asked by the committee to discuss the ways in which smart growth and greater investment in less oil-dependent transportation choices could help improve our energy security and reduce the burden facing Americans due to high gas prices. My testimony will focus on three main areas: First, what is the role that smart growth can play in reducing our oil dependence; second, what are some of the most effective policies and practices that have been implemented around the country in this area, and finally, how can Congress go further in helping communities reduce oil consumption and meet the growing demand for more walkable communities with greater transportation choices.

We know that our country needs to significantly reduce our dependence on oil to make us more economically secure and to protect Americans from rising fuel prices. Given that 70 percent[1] of the oil consumed in this country is from the transportation sector, any strategy to make use more energy independent needs to have as a leading component reducing oil use in this sector.

There are three main ways that oil consumption in the transportation sector can be reduced: we can make our cars more fuel efficient so they consume less oil; we can power them on alternative sources of energy; and thirdly, we can reduce demand so that people are driving less because they have other alternatives. While those first two solutions are important and need to be a critical part of the solution, the third option has three important advantages. First, the most cost-effective, cleanest gallon of oil is the one that's not used. Second, we already have the technology available to help people drive less—we know that investing in public transportation, making communities more walkable, and creating more housing near job centers results in less driving.

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[1] Energy Information Administration (2006)

Finally, helping people drive less doesn't require that people buy a new car, as these other solutions do. Instead, it actually helps people save money overall. Families in areas with good transit and walkable neighborhoods pay less than 10 percent of their income for transportation, while families living in areas with fewer alternative transportation options pay upwards of 25 percent. Access to transit can reduce the need of a car in a two- car household, resulting in a savings of $6,000 a year.[2]

My testimony will focus on how smart growth is the most effective means of achieving this third solution of reducing demand for oil, by helping give people the choice to drive less. Smart growth is a concept that has been used to mean a pattern of development that generally consumes less land than much traditional sprawl in the U.S., provides a range of housing options, prioritizes growth in already-developed areas, makes shops and services convenient to reach, and emphasizes making communities more walkable and public transit-friendly. For much of our country's history our small towns, cities, and neighborhoods could be considered 'smart growth.' However, in the 1950's and '60's with cheap fuel and abundant land, we started passing transportation and land use policies that have made many of our communities today unwalkable, cut off from jobs and services, and without any alternative to driving long distances. Under most of the country's land use regulations, a neighborhood like Georgetown or Old Town Alexandria would be illegal today. We have literally built oil dependence into our communities an as a result we are ill-equipped to deal with a world of $4 a gallon gas.

Smart growth and investment in greater transportation choices has been a proven means of boosting economic development while reducing oil consumption, and helping people avoid high gas prices and time stuck in traffic. In the recent book *Growing Cooler,* a publication from the Urban Land Institute and Smart Growth America, analysis on the relationship between development patterns and energy shows that just from land use changes alone, people drive about a third less on average in a smart growth neighborhood compared to others. The findings show that people who move into compact, "green neighborhoods" are making as big a contribution to reduce oil consumption as those who buy the most efficient hybrid vehicles, but remain in car-dependent areas. An analysis by NRDC found that shifting just 10 percent of of new housing to smart growth over 10 years would save 4.95 billion gallons of gasoline, 118 million barrels of oil, and $220 billion in household gas expenses.[3]

By adding in greater investment in public transportation and other transportation choices, the result is even more significant reductions in driving rates and oil consumption. In the San Francisco Bay Area, vehicle miles traveled for households living within ½ mile of transit is half that of families living in suburban locations more than 1-mile from rail or ferry stops.[4] The explanation is simple: communities that are walkable and transit-

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[2] Reconnecting America's Center for Transit Oriented Development. Realizing the Potential: Expanding Housing opportunities near Transit. (April 2007)

[3] NRDC (2008)

[4] Metropolitan Transportation Commission. New Places, New Choices: Transit-Oriented Development in the San Francisco Bay Area. (November 2006)

friendly, with shops, services, and jobs in closer reach give people the opportunity to drive less. And overwhelmingly, when people are given the choice to spend less time in their car and more time with their families, they do.

An important point is that investment in public transportation alone isn't enough to reduce vehicle miles traveled; it needs to be complemented with the land use changes that help support transit by increasing the number of people who live and work in close proximity to transit stops. For example, in Multnomah County, Oregon, residents without access to good transit made 82 percent of their trips by car. For residents that lived near good transit alone, that number dropped to 74 percent. But for residents living near transit with supportive development, that number dropped substantially more to 58 percent. Additionally, the distance that the average resident traveled by car decreased twice as much when transit was paired with good land use.[5]

Several communities and cities around the country have led the way in encouraging walkable, convenient communities with a range of transportation choices. Portland, Oregon, with a reputation as a livable, healthy, and prosperous city, saved the equivalent of $2.6 billion annually in gasoline and time because of measures the city implemented to reduce the need for residents to drive, including smart growth zoning regulations that helped make neighborhoods more walkable and supported the institution of a light rail system. Per capita vehicle miles traveled rates in Portland are 20 percent lower than the national average for other large metro areas, according to a CEOs for Cities report.[6]

Arlington's work to expand high-density, mixed-use development around its Metrorail stations in the Rosslyn- Ballston corridor has led to high levels of development with little growth in vehicle miles traveled, meanwhile neighboring counties have seen rapid growth in traffic. This development pattern didn't happen by accident; Arlington made significant changes to its land use regulations, including zoning overlays, to actively encourage this kind of mixed use, compact, Metro-oriented growth. Arlington also undertook several initiatives to make the area more walkable, including a program to retrofit existing streets for pedestrian friendliness, initation of a car-sharing program, and development of a series of initiatives to boost Metro ridership. More than just its impact on driving rates, this transit-oriented development pattern and investment in transportation choices was a successful economic development strategy; roughly a third of the County's tax base is from just this corridor alone.

In Atlanta, Georgia, the Atlantic Station® community is a 138-acre environmental redevelopment and reclamation of the former Atlantic Steel Mill that has helped residents and workers significantly reduce driving rates. The largest urban brownfield redevelopment in the U.S., this property is a national model for smart growth that includes 6 million square feet of LEED-certified office space, 2 million square feet of retail and entertainment space, 1,000 hotel rooms, and will have between 3,000 and 5,000 residential units upon full built-out. The complex was designed so people can leave their

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[5] Portland Metro 1994 Travel Behavior Survey

[6] CEOs for Cities. Green Dividends for Portland. July, 2007

cars parked. The Atlantic Station neighborhood operates a transit shuttle system that circulates between a MARTA station and the Atlantic Station community, which carries 60,000 people a month. Space is reserved for light rail service in anticipation of future transit investments. The project has also started a "Go Carless" campaign to encourage car-dependent Atlantans to consider the advantages of living working and playing in a walkable, transit-friendly community. Recent travel surveys show that residents of Atlantic Station average 8.6 miles per day in their care, compared to an average of 32.4 miles a day compared to an average of 32.4 miles a day for the average Atlantan.

Smart growth strategies are applicable to rural areas as well as cities, This approach has helped not just reduce oil consumption and driving, but improved water quality, reduced infrastructure costs, and revitalized Main Streets across America. In Littleton, New Hampshire, a small town with a population of a little over 6,000, the loss of manufacturing jobs left a poor prognosis for the future of the community. But the town government proactively invested in the town center in partnership with the National Main Street Program. This effort was incredibly successful; the revitalized downtown brought in new jobs, businesses, residents, and consumers. People in Littleton are now walking around downtown to shop instead of driving to the regional mall located further on the periphery.

These communities are reaping the benefits of their decision to encourage smart growth today—their residents are less impacted by high gas prices because they have alternatives to driving, and studies show that housing values and foreclosure rates have remained low relative to the hardest hit neighborhoods which have been the exurban communities on the edge without alternatives to driving. However, it's important to note that most communities that opted to "grow smart" didn't pursue that strategy out of a desire to reduce oil consumption, preserve housing values, or reduce global warming emissions from cars, even though all of them are seeing those results today. Instead, many communities and developers have invested in smart growth because there is a huge unmet demand for these kinds of neighborhoods and smart growth makes communities more vibrant, with a high quality of life that many people today desire. Additionally, instead of costing communities money, smart growth saves money in the long term because it reduces spending on infrastructure. For example, a new home 10 miles from downtown costs taxpayers twice as much on average as a home in a central city area due to infrastructure costs.[7]

The surge in gas prices is merely accelerating existing, underlying trends pointing to an unmet need for more walkable, convenient communities with greater transportation options. A 2004 Survey by Smart Growth America and the National Association of Realtors showed that 6 in 10 prospective homebuyers wanted walkable neighborhoods. Part of the reason for this shift is changing demographics. With a large section of the population getting beyond driving years and fewer households with children, the large single family suburban home is now the American dream for only a segment of our

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[7] National Association of Local Government Environmental Professionals and Smart Growth Leadership Institute. Smart Growth is Smart Business. (2004)

nation's citizens. By 2025, roughly a quarter of households will have children, compared to half of all households at the height of the baby boom.

Real estate analysis has shown that aging baby boomers, as well as young people in their 20's and 30's are showing a much higher preference for homes in compact, walkable neighborhoods and are representative of a higher proportion of the home-buying public than ever before. Projections by Chris Nelson at Virginia Tech University show that the demand that will exist for large lot single family homes in 2025 is actually already more than met by the supply we have today.

As a result, smart growth isn't just good for reducing our dependence on oil; it's also good for business and our economy. An increasing number of developers are capitalizing on these trends by specializing in infill development, conversion of historic properties and warehouses, and development around transit centers. Yet huge policy barriers on every level of government still exist that make this kind of development, which reduces our dependence on oil, harder to do than development that increases oil consumption, increases the need for driving, and forces people to spend more at the gas pump.

Our outdated tax, land use, and transportation system was largely designed to meet the development needs of our country in the 1950's and '60's. On the local level, most zoning and land use codes make it illegal to do mixed use development, which means that too many of our communities have become bedroom communities cut off from convenient access to shops and services. We've hurt the character and economic vitality of many of America's small towns and forced people to drive long distances by making it easier and cheaper for businesses to locate by an interchange instead of on our Main Streets. On the federal level, our transportation system has subsidized low density expansion and made it easier to build more highways than meet the need for quality public transportation. It's time to bring our policies into the 21st century and ensure we're meeting the needs of our economy and our citizens today, as well as helping to solve important national problems like energy independence and climate change.

Congress has instituted some programs and policies that should be applauded for helping to encourage smart growth and reduce our dependence on driving. Tax credits that encourage brownfields redevelopment have helped make projects like the Atlantic Station community possible and led to major economic investments and environmental improvements in our older cities and towns. Similarly, the historic preservation tax credit, which encourages the rehabilitation of historic properties and is matched by many state programs, has revitalized many older neighborhoods and helped concentrate development to support walking and public transportation. Finally, the federal government has started to invest more money in public transportation and recognize the importance of travel options beyond driving. In ISTEA, the transportation legislation passed in 1991, Congress boosted funding for transit, recognized walking and biking as valid modes, and gave metropolitan areas some direct funding to help solve their transportation challenges.

Yet we need to do much more at every level of government to encourage the kind of development and transportation we know will reduce our dependence on oil. Fortunately,

these changes will not only improve our energy security, but they will also strengthen our economy, revitalize our cities and towns, and provide the kinds of neighborhoods and transportation choices that Americans desperately want. Only 5 percent of Americans today live within a half-mile of quality public transportation. Yet of those that do, 33 percent regularly use transit and 44 percent regularly travel by walking, bicycle, or transit.

We have three main categories of federal policy recommendations to reduce our dependence on oil and help give Americans cheaper, better alternatives to driving:

1. Target 10 percent of the revenues from climate change legislation to help encourage walkable neighborhoods with better public transportation options.
2. Ensure that the next surface transportation bill, up for reauthorization in 2009, reduces our dependence on oil and our global warming emissions.
3. Reform the current tax code to better encourage the kind of development and transportation choices that result in more energy efficient, lower cost options for Americans.

In terms of the first policy recommendation, Congress needs to recognize that we will be unable to meet the greenhouse gas reductions scientists recommend without fundamentally altering our country's development patterns. Driving rates have increased by three times the rate of population growth since 1980, in large part due to our development patterns. Even with gas price increases, if we don't give people alternatives, most Americans will have no other choice than to drive longer and longer distances in the future, which will make us more dependent on oil instead of less.

Giving people the option to live closer to work, to walk to run errands, and to take public transportation is critical. In a future carbon constrained world, Americans will be pressed even harder to deal with the high cost of driving. For low income and working class families, Congress needs to give people alternatives to paying that high cost. Walking, biking, and public transit are low cost options for people that reduce our dependence on oil and decrease global warming pollution.

We propose significant funding from a cap-and-trade climate bill (10% of the total revenues generated) be directed to state, regional, and local governments to provide their citizens with greater transportation options and incentivize smart growth development. These funds should be directed to two purposes: helping communities retool and build the technical capacity to plan for more energy efficient development, and a performance-based fund for projects in the plans to reduce vehicle miles traveled—including better transit service, infrastructure to support infill development, sidewalks and bike lanes or other methods shown to reduce VMT.

Secondly, we also need a transportation bill that moves us in the right direction toward an energy independent and carbon-constrained future. We cannot continue our current system, which makes it much easier to build a new highway than a new transit system, provides only minimal investment in biking and walking, and rewards states through the

highway formula for higher oil consumption and VMT. We must significantly boost investment in public transportation and move to a performance-based system that rewards states and communities for making progress on national priorities, including reducing our dependence on oil. Finally, we need to link our transportation investments with our investments in housing and infrastructure so that we are building communities that work as a whole.

Finally, we need to examine the current tax incentives and ensure that we're incentivizing the kind of development and transportation choices that reduce people's reliance on cars and oil consumption, rather than increasing them. Tax incentives like the Historic Preservation Tax Credit, the Low Income Housing Tax Credit, the Brownfields Program and others should provide bonuses for use in locations near transit and in compact, walkable neighborhoods to maximize their energy and climate impacts. In addition to having tax incentives for green buildings, we should have a 'Smart Location' tax credit and targets for 'Location-Efficient Mortgages,' which would make it more affordable for people to live in places where they'll be able to drive less.

Several existing legislative vehicles help move us toward a future where we can spend less on gas, have more transportation choices, and reduce our oil consumption. We support the Complete Streets legislation sponsored by Senator Tom Harkin in the Senate (S. 2686) that would help get the most out of federal transportation investments by ensuring the streets we build with federal money work for all Americans—whether by walking, biking, taking the bus, or driving, regardless of age or ability. This bill would give Americans better transportation options while encouraging healthier lifestyles and reducing our dependence on driving. In another few weeks, Senator Tom Carper will be introducing legislation that would target funding from a cap-and-trade system to states and local governments that are taking steps to help residents drive less by investing in smart growth and greater transportation choices. Finally, we support legislation that would expand the Historic Preservation Tax Credit (S.584) and the Brownfields programs, which both aid investment in areas that are generally more walkable and better served by public transportation.

Again, I thank you for the opportunity to testify today. We all agree that reducing our dependence on oil and helping Americans deal with gas prices are important national goals. Smart growth development, which helps people have the choices to drive less, is an important means to those goals that also delivers other critical benefits and meets the growing demand for these kinds of communities. Smart Growth America looks forward to working with you to help encourage this kind of growth and greater transportation alternatives through federal legislation.

Offshore Wind Energy:
An Immense US Natural Resource

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HSGAC Hearing "Energy Security: An American Imperative"
July 22, 2008

Outline

Maine Heating
State of Emergency

Food or heat?

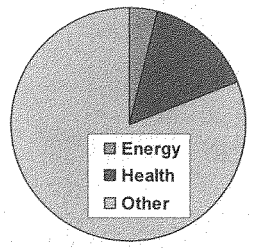
Outmigration?

- 80% use heating oil
- Heating oil costs tracks crude
- Next winter's heating oil: $5/gallon
- Maine family heating costs next winter: $5,000
- In 2020, family heating costs: $10,000 ('08 dollars)

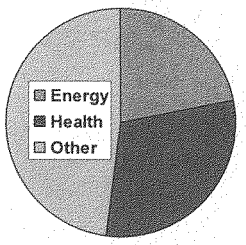
How to Break a 'Maine' Budget 1998-2018

"Energy" =
50% Transportation
40% Heating
10% Electric Power

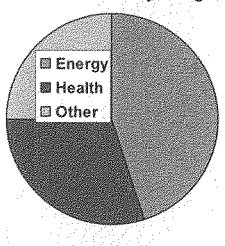
1998 Maine Family Budget



2008 Maine Family Budget

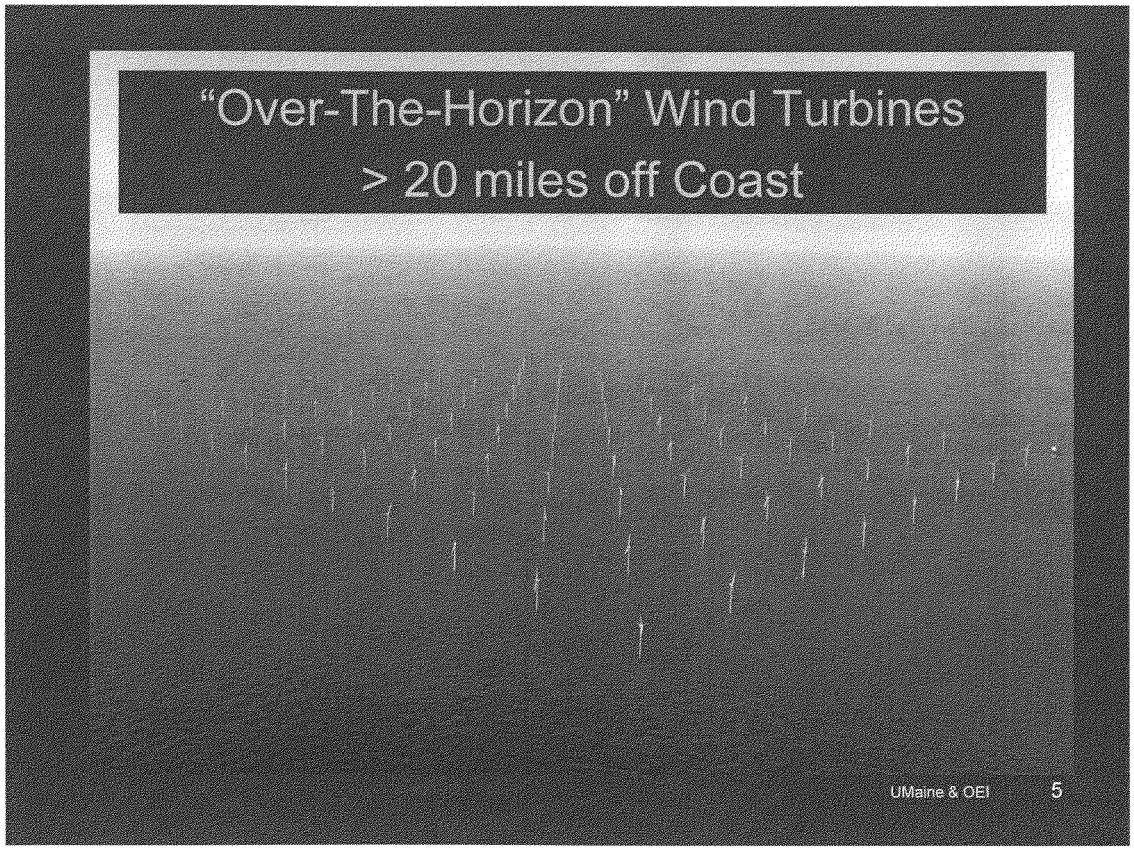


2018 Maine Family Budget



This makes the "happy" assumption that health care costs do not grow past 30% of the average family's budget in 2008-2018

Ocean Energy Institute


"Over-The-Horizon" Wind Turbines
> 20 miles off Coast
UMaine & OEI
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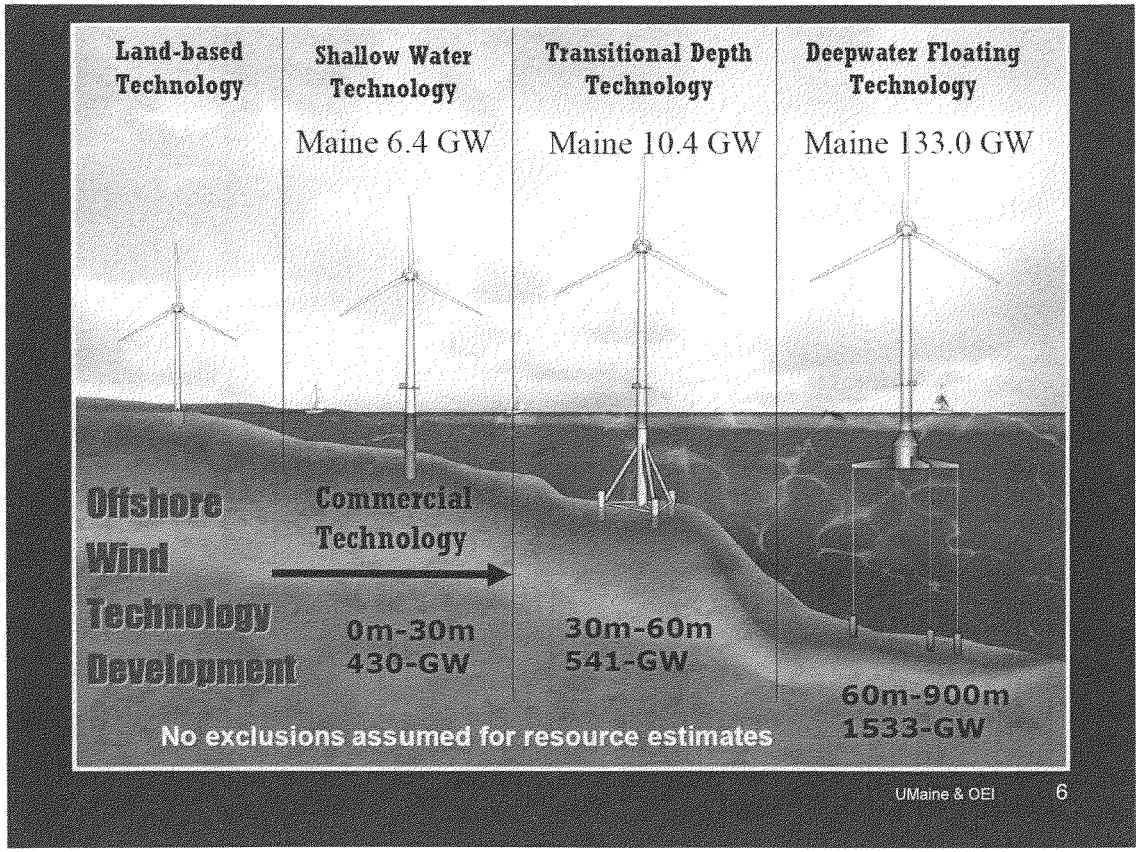
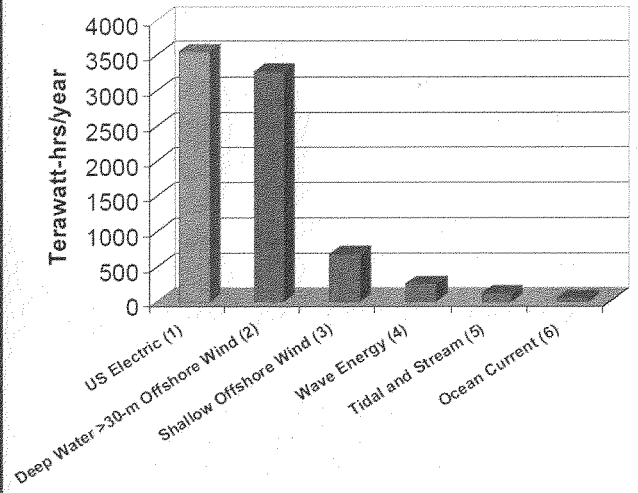

Land-based Technology
Shallow Water Technology
Transitional Depth Technology
Deepwater Floating Technology
Maine 6.4 GW
Maine 10.4 GW
Maine 133.0 GW
Offshore Wind Technology Development
Commercial Technology
0m-30m
430-GW
30m-60m
541-GW
60m-900m
1533-GW
No exclusions assumed for resource estimates
UMaine & OEI
6

US Marine Renewable Energy Electric Potential Estimates (7)



Assumptions

1. U.S. electric consumption based on 2005 EIA statistics.
2. Class 5 wind or better; depths between 30-m and 900-m included; 60% exclusions; HI and AK not included; 0-50nm from shore; 45% Cap factor; Source: NREL.
3. Class 5 wind or better; depths between 0-m and 30-m; included; 60% exclusions; HI and AK not included; 0-50nm from shore; 45% cap factor; Source NREL.
4. 15% of incident wave energy; 20% conversion losses; AK and HI included; Wave climate 10kW/m or better; Source EPRI.
5. Estimated from aggregate siting studies; 15% extraction permitted; In stream river kinetic estimated by EPRI..
6. Estimated from *Coriolis Study, Aquantis*, and FAU; Miami/Gulf Stream region only. 57% capacity factor; 10-GW rated capacity.
7. OTEC, salinity gradient, marine biomass not evaluated.

NREL National Renewable Energy Laboratory

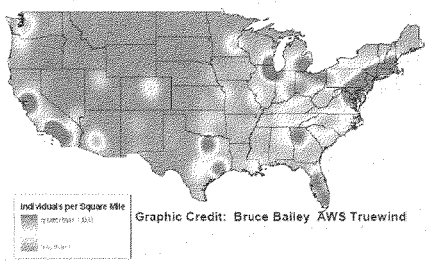
Why Marine Renewables?

28 coastal states use 78% of the electricity in US

Many Coastal Load Centers Cannot Be Served by Land-based Renewable Resources

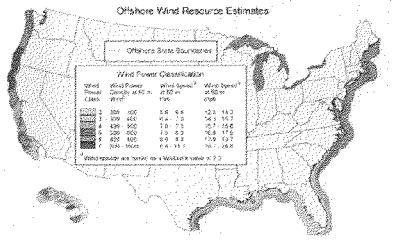
Renewable Energy Goals Cannot be Achieved Without Offshore Contributions

US Population Concentration

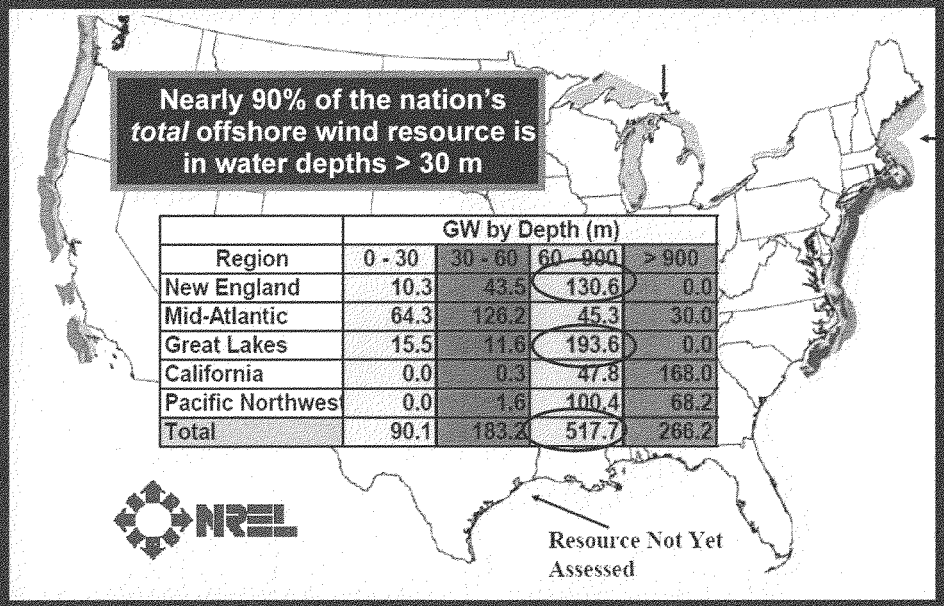


Graphic Credit: Bruce Bailey AWS Truewind

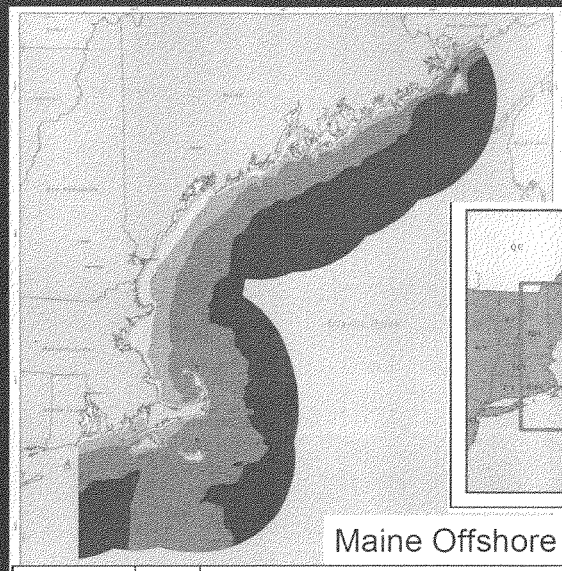
U.S. Wind Resource



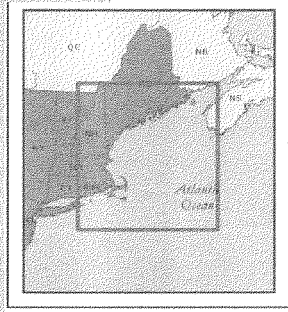
Floating Offshore Wind Technology Innovated in Gulf of Maine Exportable to Rest of US and World



	GW by Depth (m)			
Region	0 - 30	30 - 60	60 - 900	> 900
New England	10.3	43.5	130.6	0.0
Mid-Atlantic	64.3	126.2	45.3	30.0
Great Lakes	15.5	11.6	193.6	0.0
California	0.0	0.3	47.8	168.0
Pacific Northwest	0.0	1.6	100.4	68.2
Total	90.1	183.2	517.7	266.2



New England Offshore Mean Wind Speed at 90-m



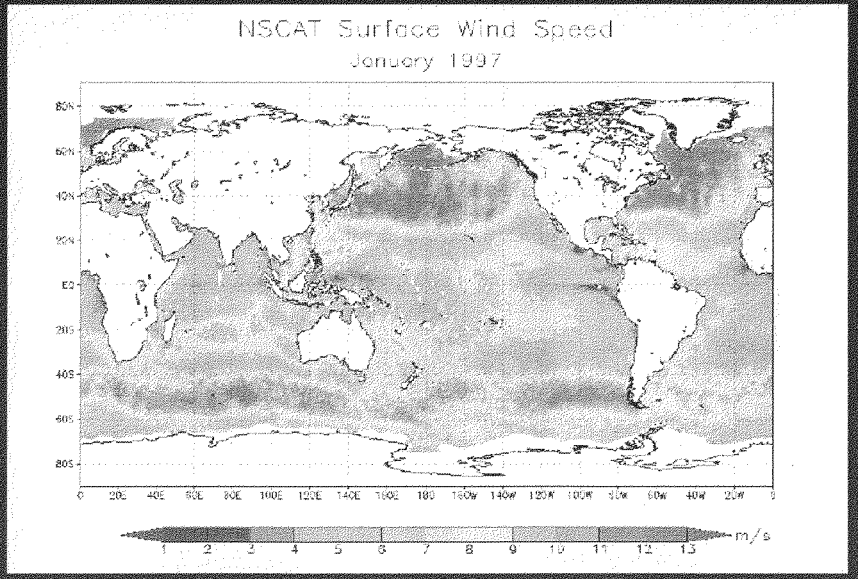
Mean Speed at 90 m

mph	m/s
< 12.3	< 5.5
12.3 - 13.4	5.5 - 6.0
13.4 - 14.5	6.0 - 6.5
14.5 - 15.7	6.5 - 7.0
15.7 - 16.8	7.0 - 7.5
16.8 - 17.9	7.5 - 8.0
17.9 - 19.0	8.0 - 8.5
19.0 - 20.1	8.5 - 9.0
20.1 - 21.3	9.0 - 9.5
> 21.3	> 9.5

Maine Offshore Wind Potential

Maine (MW of wind potential)		Distance from Shoreline											
		0–3 nm (state waters)				3–12 nm				12–50 nm			
	Wind	Depth Category (m)				Depth Category (m)				Depth Category (m)			
	Class	0–30	30–60	60–900	> 900	0–30	30–60	60–900	> 900	0–30	30–60	60 - 900	> 900
	4	4,785	2,163	324	0	493	2,104	1,175	0	0	0	0	0
	5	3,663	2,442	1,112	0	657	2,029	3,697	0	0	0	0	0
	6	1,516	2,250	1,487	0	630	3,413	20,928	0	2	348	105,789	0
	7	0	0	0	0	0	0	0	0	0	0	41	0

Global Wind Speed Distribution in Northern Hemisphere Winter



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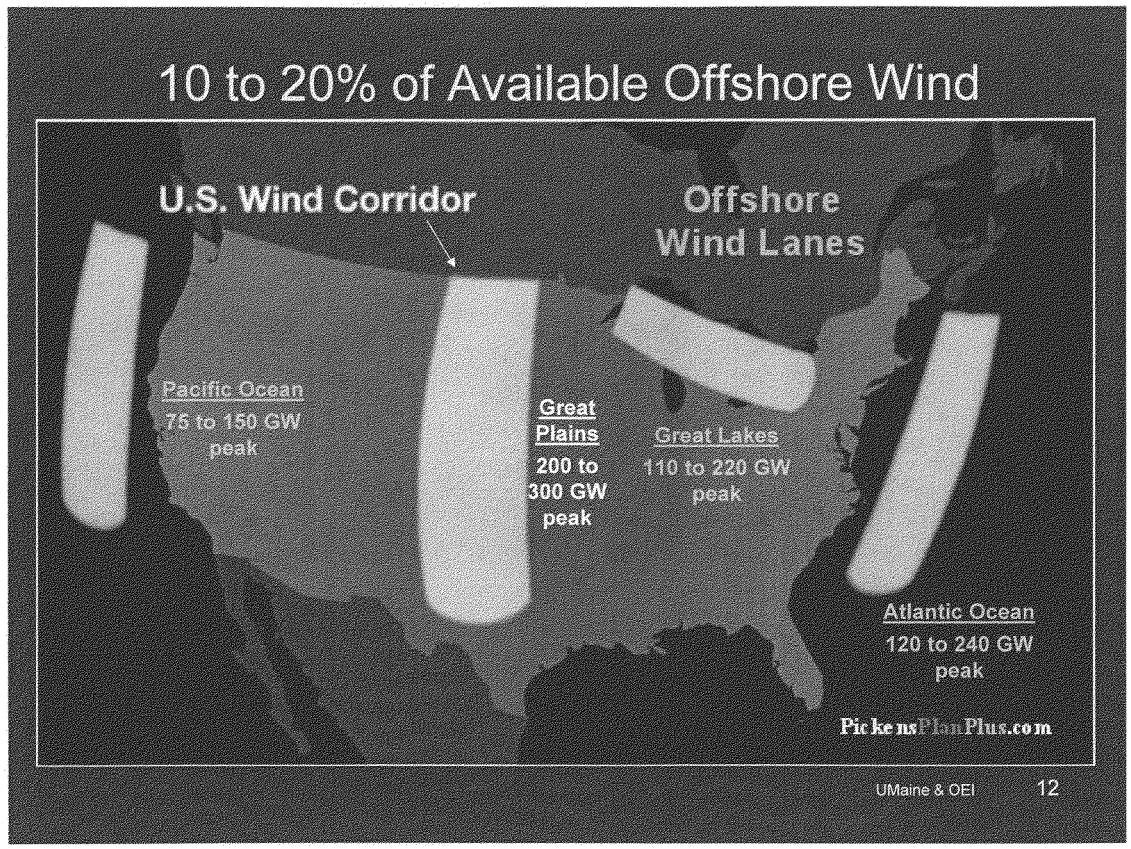
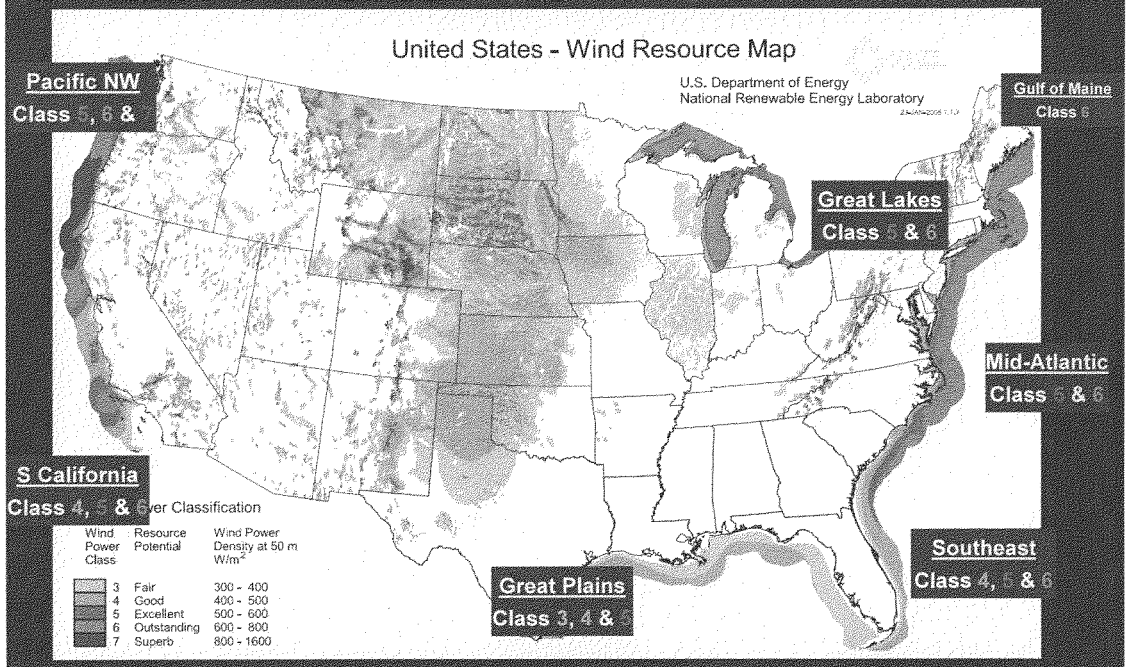
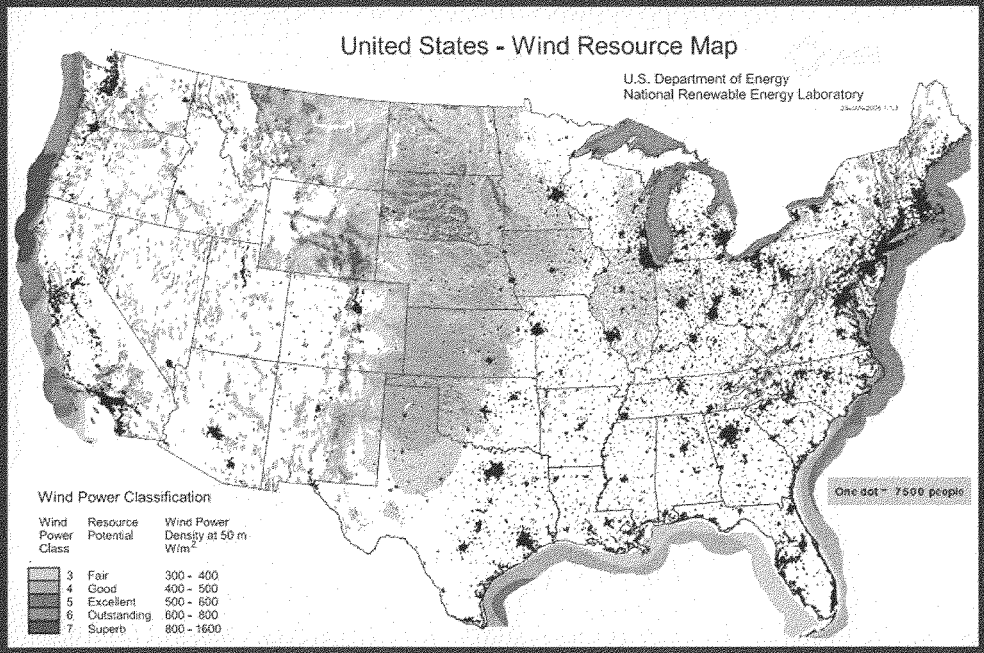
Ocean Energy Institute


10 to 20% of Available Offshore Wind
U.S. Wind Corridor
Offshore Wind Lanes
Pacific Ocean
75 to 150 GW peak
Great Plains
200 to 300 GW peak
Great Lakes
110 to 220 GW peak
Atlantic Ocean
120 to 240 GW peak
PickensPlanPlus.com
UMaine & OEI
12

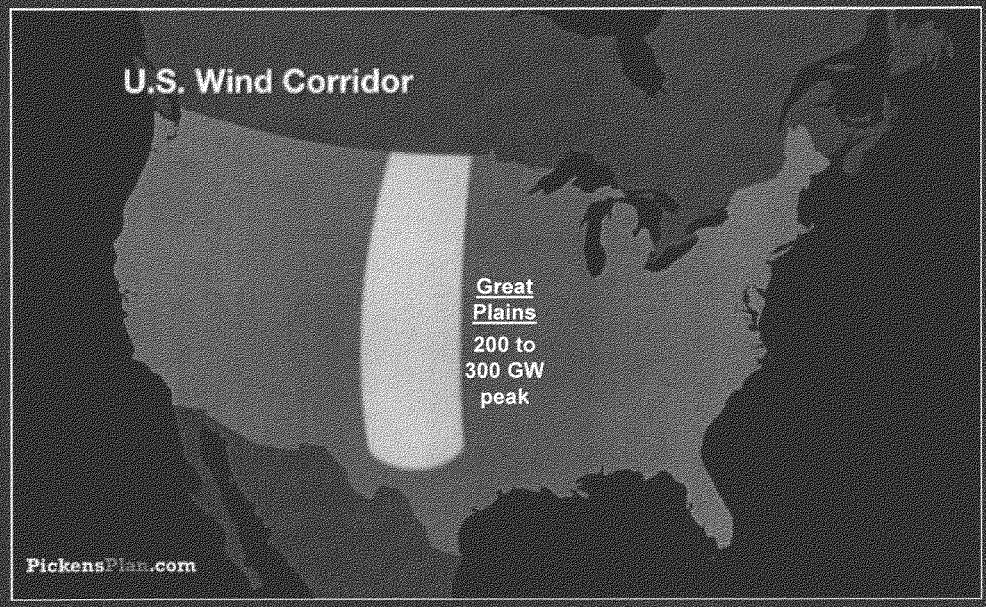
Added Value 1: Better Wind Resources



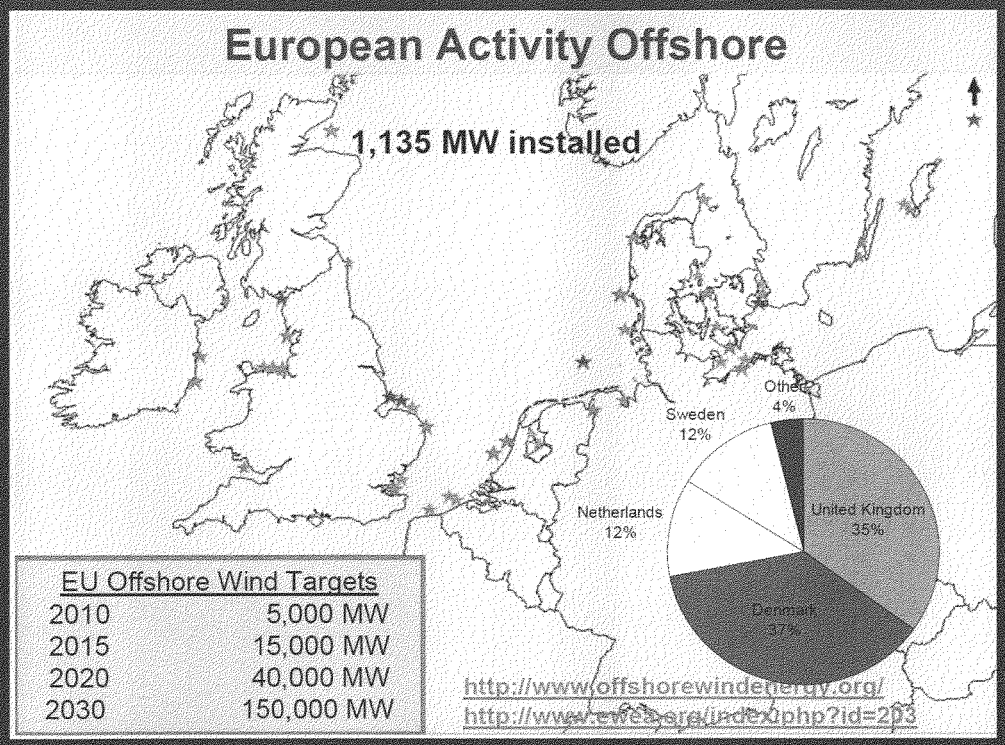
Added Value 2: Better Wind Resources Located Closer to Urban Load Centers



Added Value 3: Less Intermittency as Weather Moves from West to East

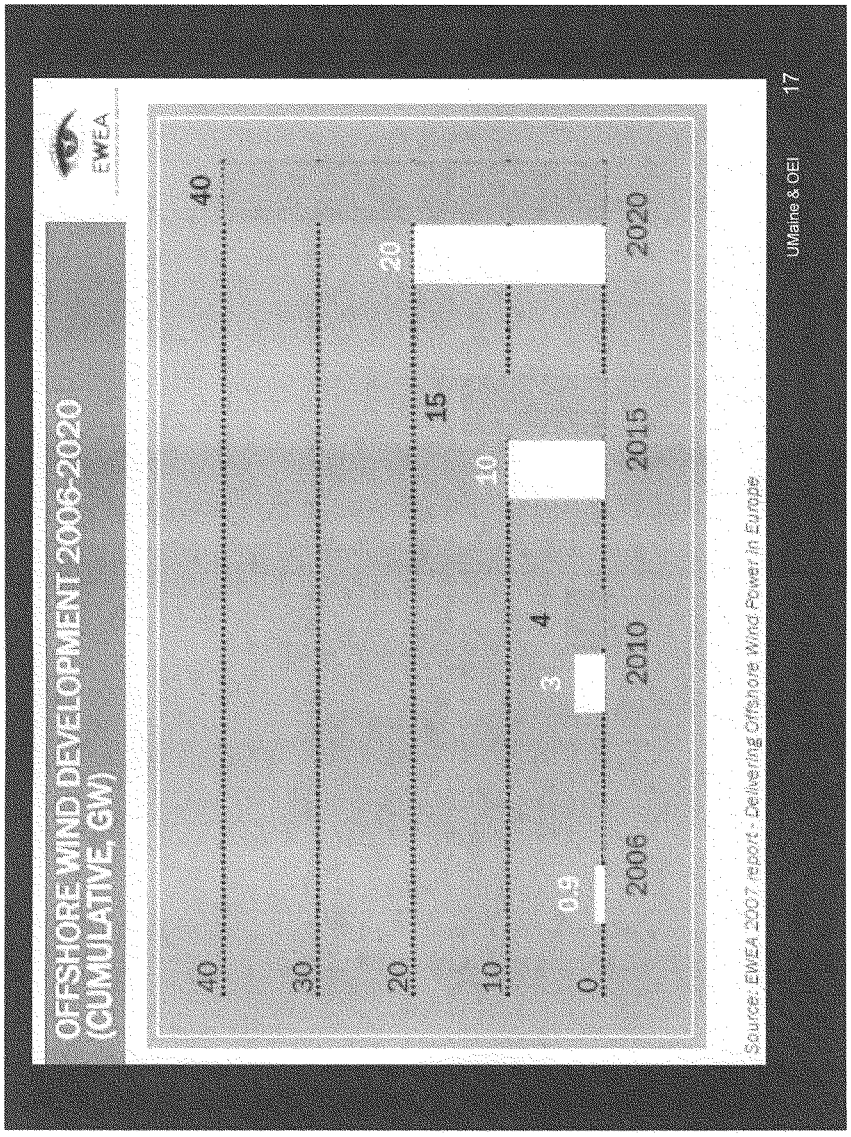


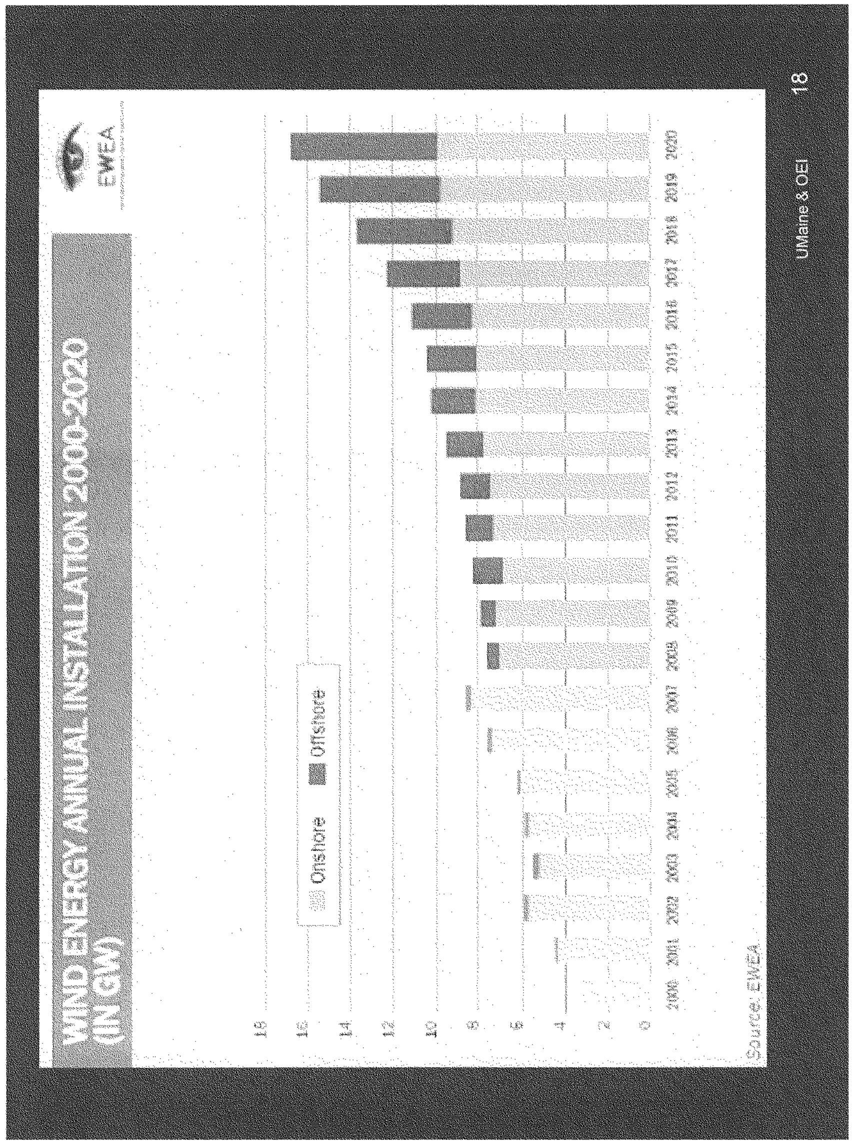
European Activity Offshore



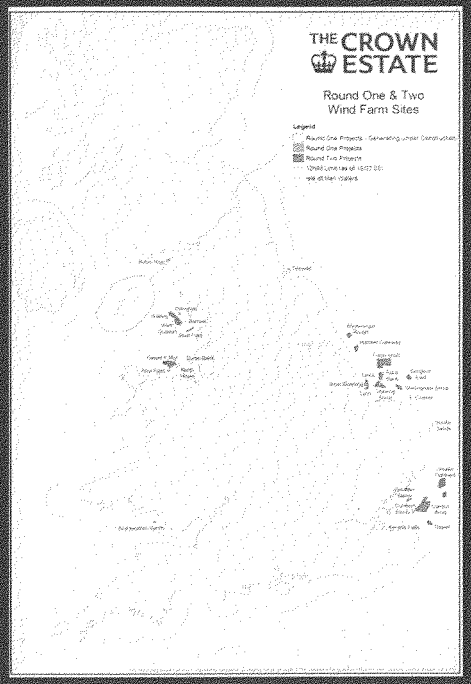
EU Offshore Wind Targets	
2010	5,000 MW
2015	15,000 MW
2020	40,000 MW
2030	150,000 MW

http://www.offshorewindenergy.org/
http://www.ewea.org/index.php?id=203

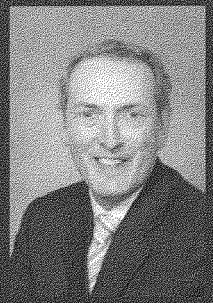

OFFSHORE WIND DEVELOPMENT 2006-2020
(CUMULATIVE, GW)
EWEA
40
30
20
10
0
0.9
3
4
10
15
20
40
2006
2010
2015
2020
Source: EWEA 2007 report - Delivering Offshore Wind Power in Europe
UMaine & OEI
17


WIND ENERGY ANNUAL INSTALLATION 2000-2020
(IN GW)
EWEA
Onshore
Offshore
18
16
14
12
10
8
6
4
2
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Source: EWEA
UMaine & OEI
18

UK Plan: 33 GW by 2020



- ✓ 7,000 offshore wind turbines around the country's coastline
- ✓ Up to 50% of Country's electricity
- ✓ Mix of sources, including nuclear to cover no-wind days



Energy Secretary John Hutton plan announced on Dec 10, 2007

http://nds.coi.gov.uk/environment/fullDetail.asp?ReleaseID=337237&NewsAreaID=2&NavigatedFromDepartment=True

Solutions for Intermittency

- Mix with traditional power generation
- Storage:
  - Pumped hydro (Norway 'battery' for Europe)
  - Plug-in Electric Hybrids
- Wide geographic coverage
- Smart grid technology

Plug-In Electric Hybrid Vehicles – Chevy Volt

http://www.gm-volt.com/

PEHV

http://www.edmunds.com/insideline/do/Features/articleId=119088

General Motors has unveiled the Chevrolet Volt concept, the company's first plug-in hybrid vehicle, at the 2007 North American International Auto Show in Detroit. The Chevrolet Volt concept is the first vehicle to use GM's new E-flex family of propulsion systems. GM claims the Volt delivers triple-digit fuel economy and can travel up to 640 miles without a fuel fill-up or a battery recharge. Scheduled for 2010 model year.

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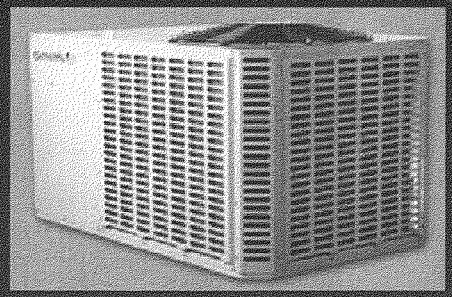
Ocean Energy Institute

Cold Climate Heat Pumps
Hallowell Intl Acadia® CCHP

The Acadia™

The Acadia™ was designed to provide years of comfort and reliability. Using electricity efficiently means that the Acadia™ can provide savings of up to 70% over other traditional heating systems. Even better, the Acadia™ was designed so that any HVAC contractor who currently works with air source heat pumps has all the tools and experience to install and service the system.

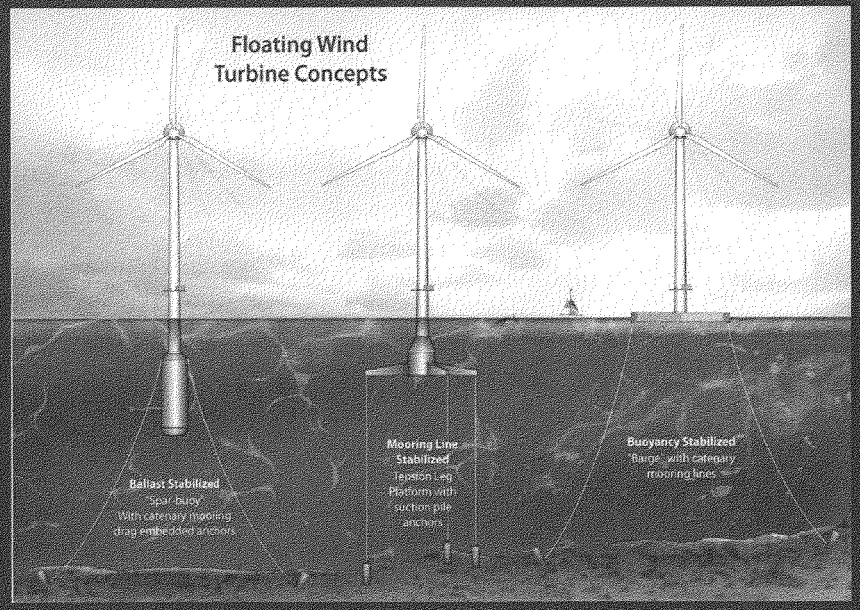


Ocean Energy Institute

R&D Needs: Deep Water

- Deep water (30m) > 90% of US resource
- Design/deploy prototype floating turbines
  - 2011 - GEN1: refine design models
  - 2013 - GEN2: optimize design
  - 2015 - 50 MW commercial farm: logistics
- 2016 - Industrial development
- $100 million R&D effort – 1 US location
- $240 million R&D effort – 3 US locations:

R&D: Floating Wind Turbines: Design and Prototype Deployment



Summary & Recommendations

1. U.S. coastal states, including Maine, have significant offshore wind resources
   -- Development of offshore wind creates much needed, clean electricity at stable prices; increased revenues across all jurisdictions; and manufacturing and project development jobs
   -- over 100,000 MW potential in Maine
   -- each 1,000 MW of wind = $2 billion in capital investment, $5 m/yr for lease payments, 1800 construction jobs, 1.8 million metric tons of carbon avoided/yr, and 18 billion cubic feet of natural gas saved/yr

2. There is a strong role for federal agencies to ensure these benefits are realized:
   -- Technology - we need an offshore technology development and demonstration program as current wind technology cannot be used in offshore environment; need several test centers as well; R&D investment: $100 million – one demo location, $240 million – 3 demo locations
   -- Resource Assessment -- we need to better understand the wind resource offshore at heights suitable for wind project development, vs. surface measurements
   -- Regulatory Framework -- we need enhanced federal, state, and local regulatory framework to ensure offshore developers, investors, and customers have a clear, timely, predictable process for their projects

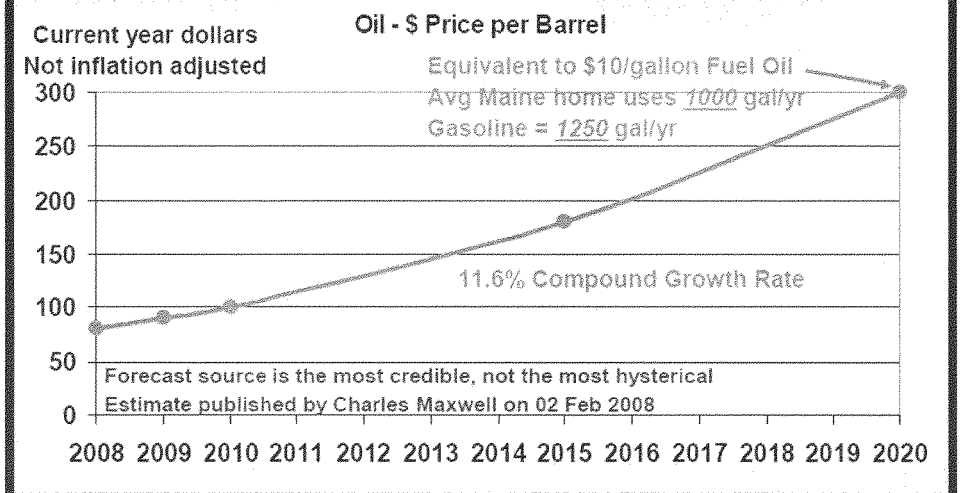
3. Role for Department of Homeland Security related to offshore wind:
   -- DHS could also look at role offshore wind turbines-based sensors and their platforms can play as early detectors of hostile ship or airborne WMDs
   -- Wind impact on DHS Mission -- we need to better understand and create tools to mitigate potential impacts of wind systems on DHS operations, such as long-range surveillance radars
   -- DHS facilities could consider their role as a potential customer of wind power to meet their Executive Order requirements for all federal agencies to increase clean power purchases

Acknowledgements

- Walter Musial, Principal Engineer, National Renewable Energy Lab (NREL Slides)
- P.J. Dougherty (formerly DOE Wind Program) SMI Inc./Helios Strategies
- George Hagerman, Virginia Coastal Energy Research Consortium, Virginia Tech Advanced Research Institute
- Mark West, SWAY, Norway Blue H USA
- EWEA
- AWEA

ADDITIONAL BACKGROUND

Anatomy of a Granite Mountain

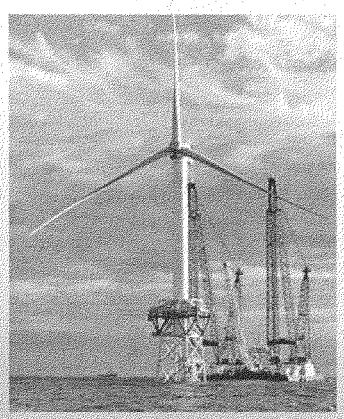


In polls taken by *Institutional Investor* magazine, Mr. Maxwell has been ranked by the US financial institutions as the No. 1 oil analyst for the years 1972, 1974, 1977 and 1981-1986. In addition, for the last 17 years he has been an active member of an Oxford-based organization comprised of OPEC and other industry executives from 30 countries who meet twice a year to discuss trends within the energy industry

Offshore Wind Benefits

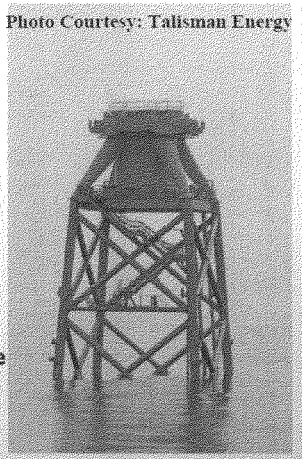
- Better wind resources
  - Less turbulence – steadier wind
  - Higher wind = better energy production
  - Higher capacity factors – load matching
- Less visual impacts than land-based.
- Proximity to load centers
  - Lowers transmission constraints
  - Serves high cost regions
  - Exploits indigenous resources
- Avoids land-based size limits
  - **Shipping** – Roadway limits
  - **Erection** – Crane limits
  - Larger machines are more economical.

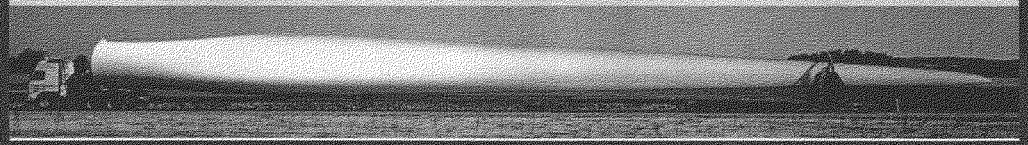
45-m Depth Offshore Demonstration Project
Talisman Energy in Beatrice Fields



- 5-MW Rating
- 61.5-m Blade Length
- Worlds Largest Turbine
- Two Machines
- 45-m Water Depths

Photo Courtesy: Talisman Energy



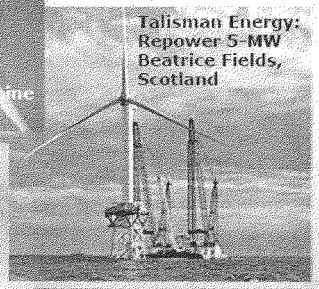


Offshore Turbine Suppliers

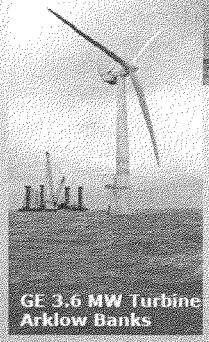
Turbine Manufacturer	Turbine model & rated power	Date of availability	Offshore Operating Experience
Bard Engineering	VM - 5 MW	2008-09	Onshore prototype 2008
General Electric	GE – 3.6-MW	2003	Commercial inactive
Multibrid	M5000 - 5 MW	2005	Onshore 2005
Nordex	N90 - 2.5 MW	2006	Offshore Demo 2003
RePower Systems	5M - 5 MW	2005	Offshore Demo 2006
Siemens	SWT-2,3 - 2.3 MW	2003	Commercial
Siemens	SWT-3.6 - 3.6 MW	2005	Commercial
Vestas	V80 - 2 MW	2000	Commercial
Vestas	V90 - 3 MW	2004	Commercial

Offshore Technology Status

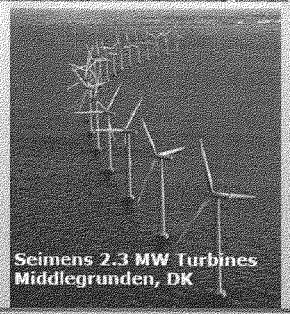
Vestas 2.0 MW Turbine
Horns Rev, DK



Talisman Energy:
Repower 5-MW
Beatrice Fields,
Scotland



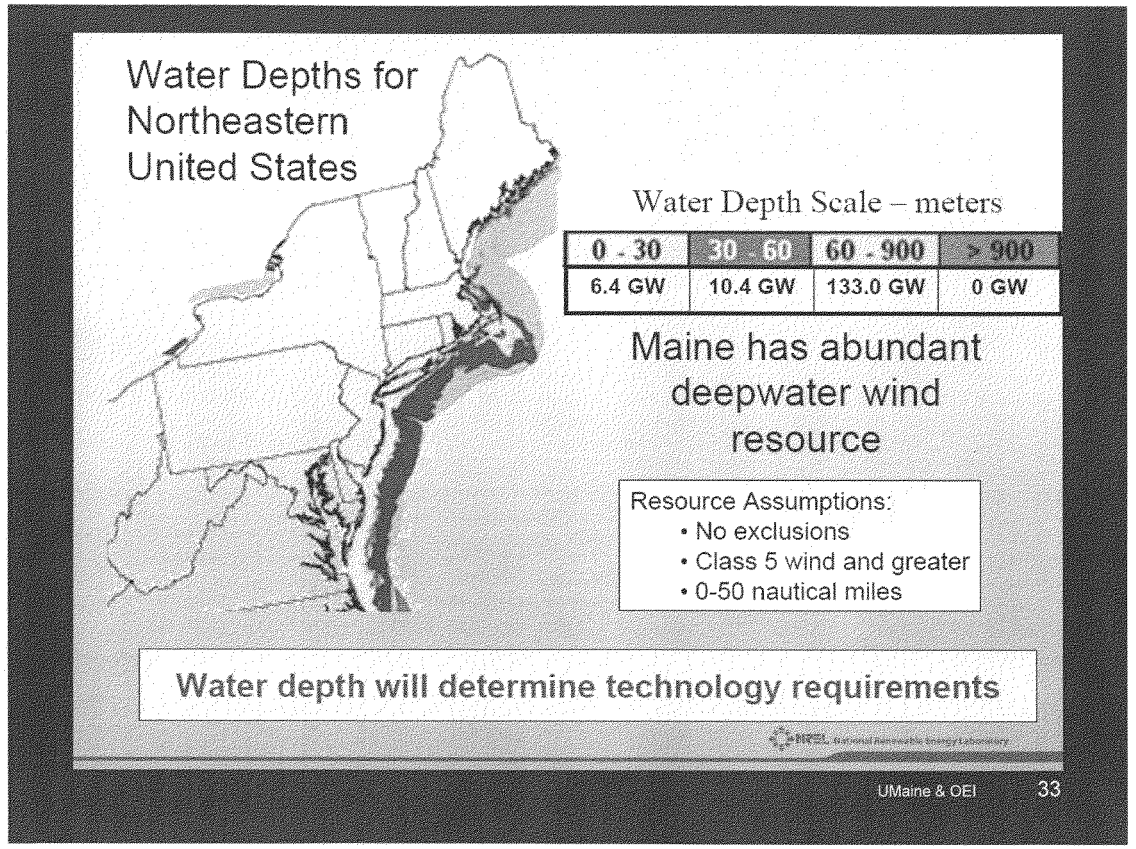
GE 3.6 MW Turbine
Arklow Banks



Seimens 2.3 MW Turbines
Middlegrunden, DK

- Initial development and demonstration stage; 22 projects, 1135 MW installed
- Fixed bottom shallow water 0-30m depth
- 2 – 5 MW upwind configurations
- 70+ meter tower height on monopoles and gravity base
- Mature submarine power cable technology
- Existing oil and gas experience essential
- Reliability problems and turbine shortages have discouraged early boom in development.
- Cost are not well established in the US.

NREL National Renewable Energy Laboratory


Water Depths for Northeastern United States
Water Depth Scale – meters
0 - 30
30 - 60
60 - 900
> 900
6.4 GW
10.4 GW
133.0 GW
0 GW
Maine has abundant deepwater wind resource
Resource Assumptions:
• No exclusions
• Class 5 wind and greater
• 0-50 nautical miles
Water depth will determine technology requirements
UMaine & OEI
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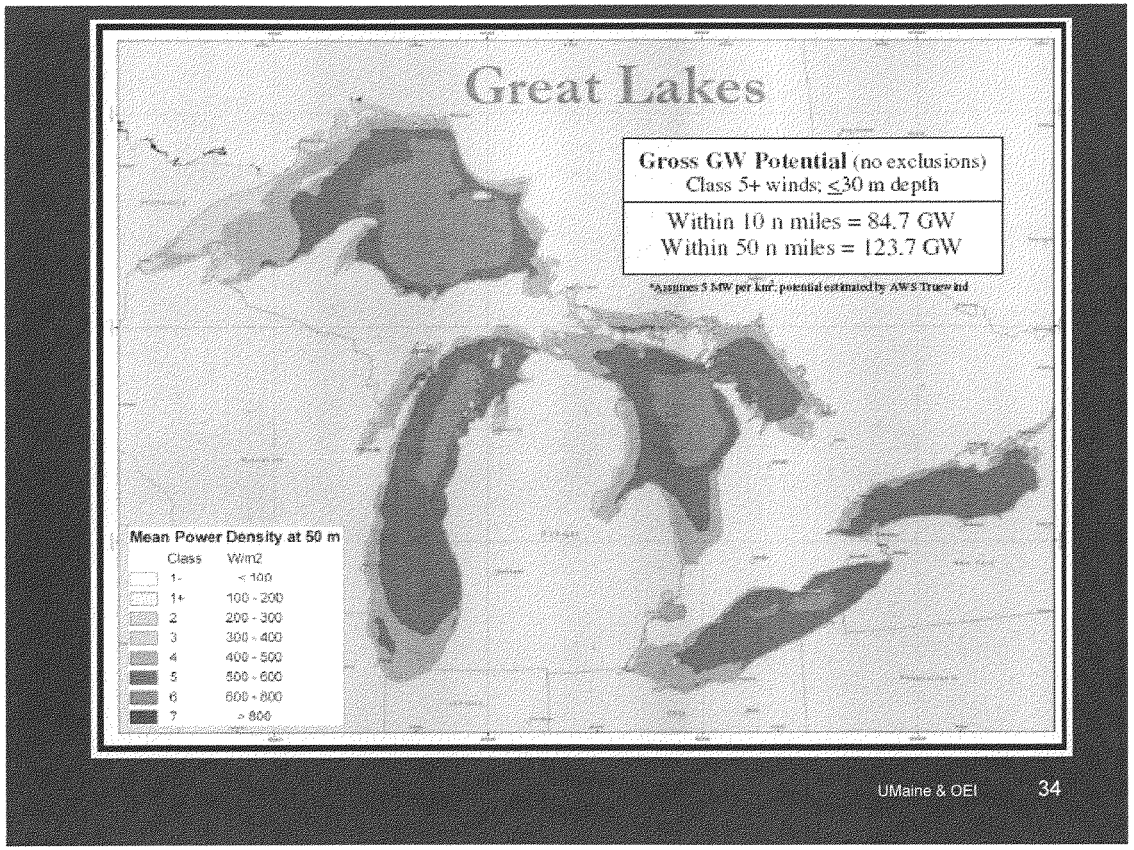
Great Lakes
Gross GW Potential (no exclusions)
Class 5+ winds; ≤30 m depth
Within 10 n miles = 84.7 GW
Within 50 n miles = 123.7 GW
*Assumes 5 MW per km², potential estimated by AWS Truewind
Mean Power Density at 50 m
Class W/m2
1- < 100
1+ 100 - 200
2 200 - 300
3 300 - 400
4 400 - 500
5 500 - 600
6 600 - 800
7 > 800
UMaine & OEI
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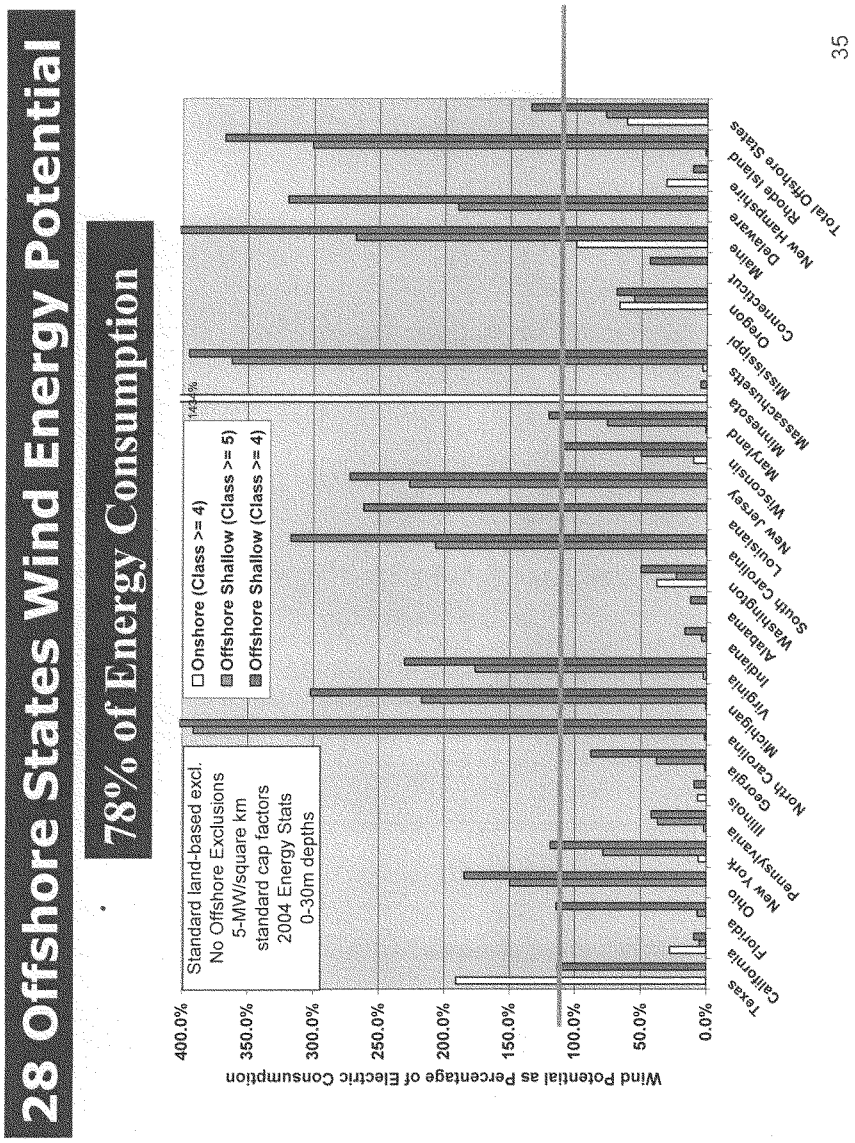
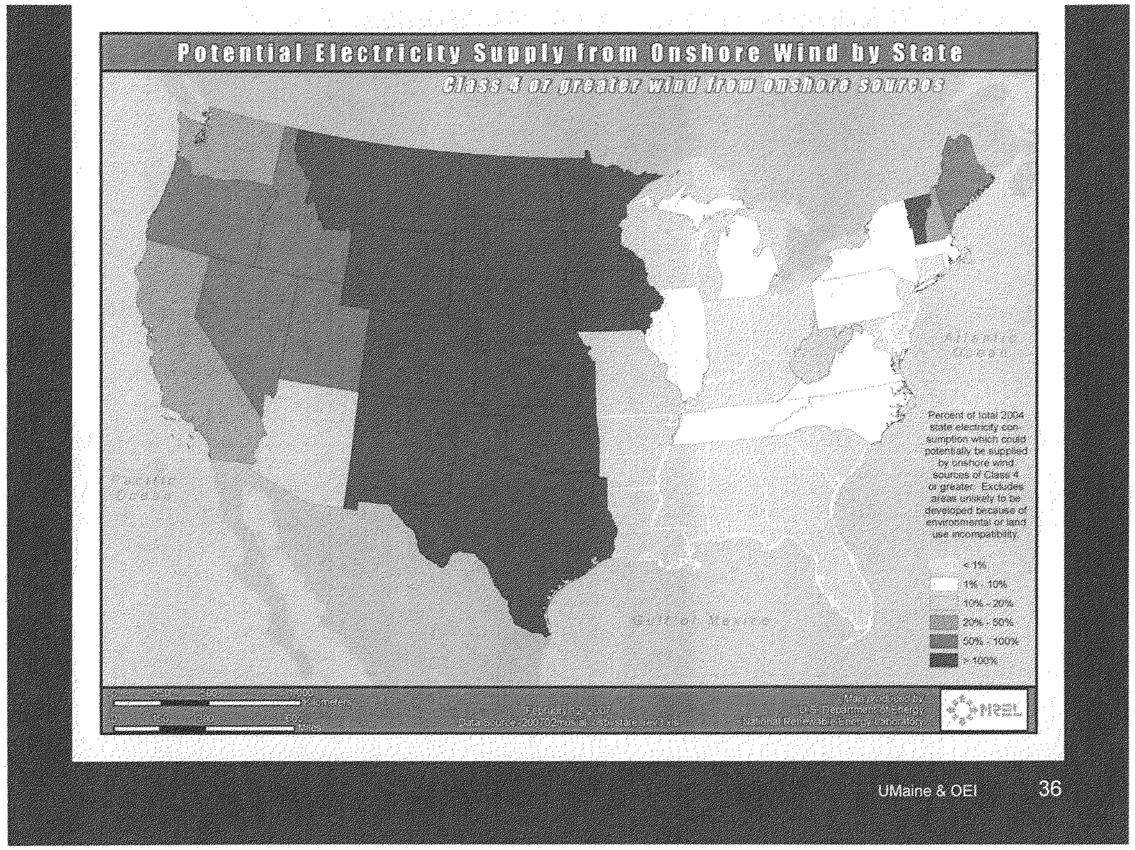

28 Offshore States Wind Energy Potential
78% of Energy Consumption
Standard land-based excl.
No Offshore Exclusions
5-MW/square km
standard cap factors
2004 Energy Stats
0-30m depths
Onshore (Class >= 4)
Offshore Shallow (Class >= 5)
Offshore Shallow (Class >= 4)
1434%
Wind Potential as Percentage of Electric Consumption
400.0%
350.0%
300.0%
250.0%
200.0%
150.0%
100.0%
50.0%
0.0%
Texas
California
Florida
Ohio
New York
Pennsylvania
Illinois
Georgia
North Carolina
Michigan
Virginia
Indiana
Alabama
Washington
South Carolina
Louisiana
New Jersey
Wisconsin
Maryland
Minnesota
Massachusetts
Mississippi
Oregon
Connecticut
Maine
Delaware
New Hampshire
Rhode Island
Total Offshore States


Potential Electricity Supply from Onshore Wind by State
Class 4 or greater wind from onshore sources
Atlantic Ocean
Gulf of Mexico
Percent of total 2004 state electricity consumption which could potentially be supplied by onshore wind sources of Class 4 or greater. Excludes areas unlikely to be developed because of environmental or land use incompatibility.
< 1%
1% - 10%
10% - 20%
20% - 50%
50% - 100%
> 100%
Kilometers
Miles
February 12, 2007
Map produced by
U.S. Department of Energy
National Renewable Energy Laboratory
UMaine & OEI
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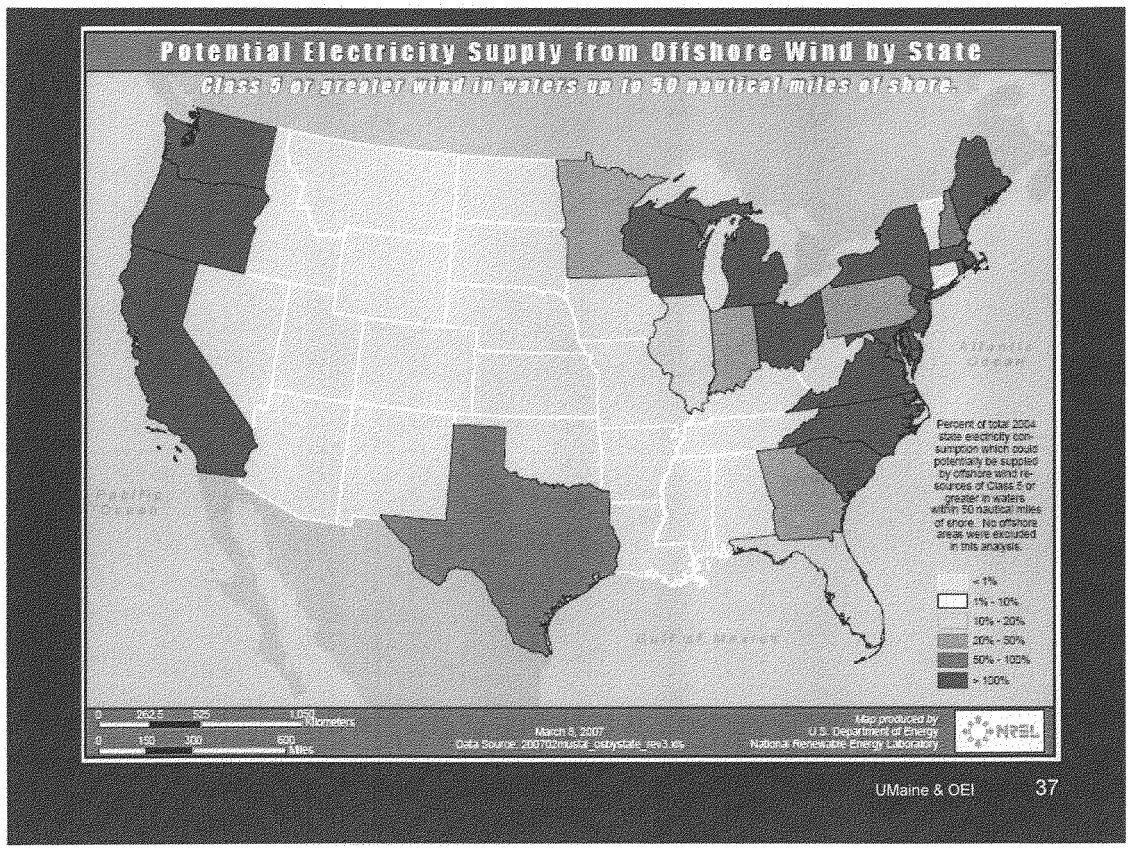
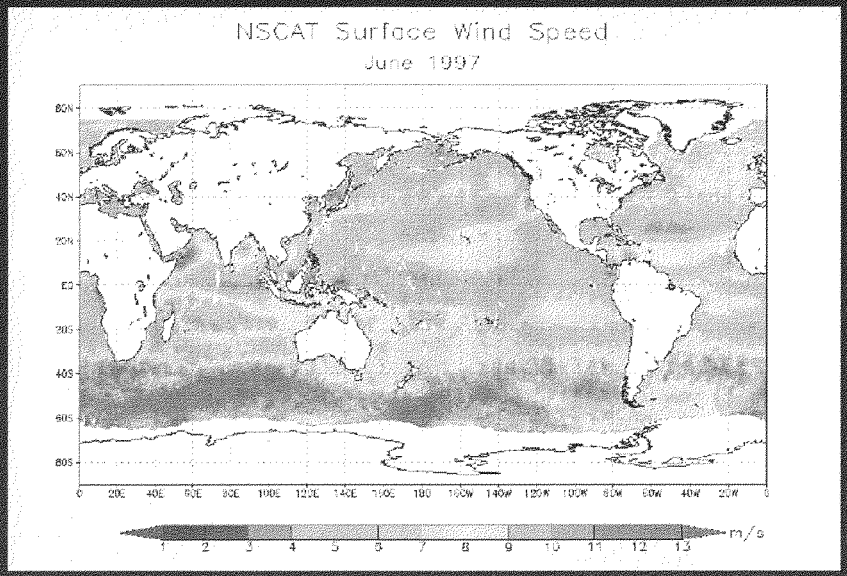

Potential Electricity Supply from Offshore Wind by State
Class 5 or greater wind in waters up to 50 nautical miles of shore.
Percent of total 2004 state electricity consumption which could potentially be supplied by offshore wind resources of Class 5 or greater in waters within 50 nautical miles of shore. No offshore areas were excluded in this analysis.
< 1%
1% - 10%
10% - 20%
20% - 50%
50% - 100%
> 100%
0 262.5 525 1050 Kilometers
0 150 300 600 Miles
March 8, 2007
Data Source: 200700mustra_cstyscale_rev3.shp
Map produced by
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

Global Wind Speed Distribution in Northern Hemisphere Summer



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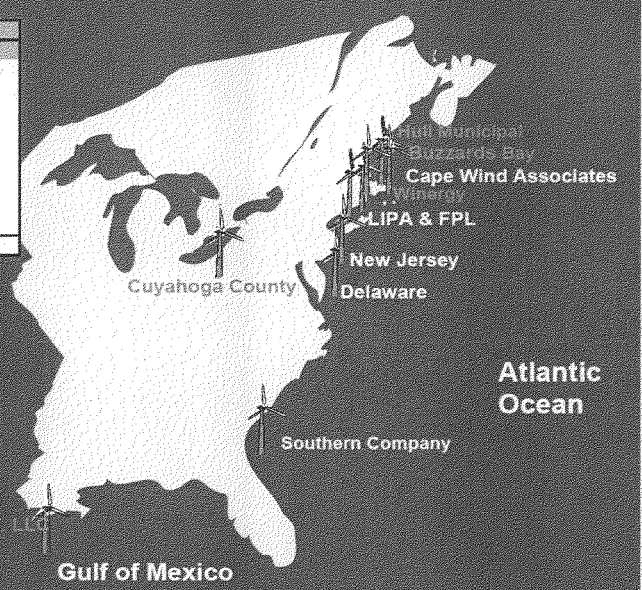
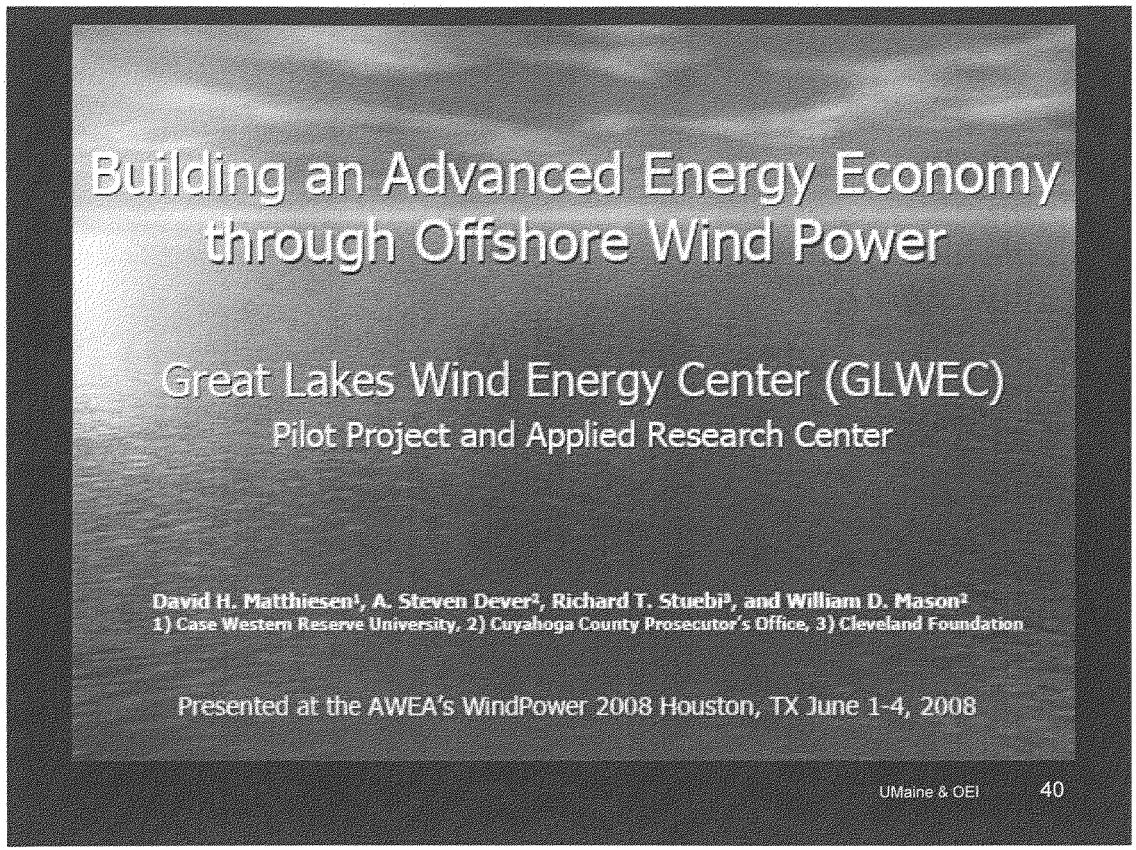
Ocean Energy Institute

US Projects Proposed

US Offshore Projects		
Project	State	MW
Capewind	MA	468
Winergy (plum Island)	NY	10
Southern Company	GA	10
W.E.S.T.	TX	150
Buzzards Bay	MA	300
New Jersey	NJ	300
Hull Municipal	MA	15
Cuyahoga County	OH	20
Delmarva	DE	450
Total		1723



No Offshore wind projects Installed in U.S. yet


Building an Advanced Energy Economy through Offshore Wind Power
Great Lakes Wind Energy Center (GLWEC)
Pilot Project and Applied Research Center
David H. Matthiesen[1], A. Steven Dever[2], Richard T. Stuebi[3], and William D. Mason[3]
1) Case Western Reserve University, 2) Cuyahoga County Prosecutor's Office, 3) Cleveland Foundation
Presented at the AWEA's WindPower 2008 Houston, TX June 1-4, 2008
UMaine & OEI
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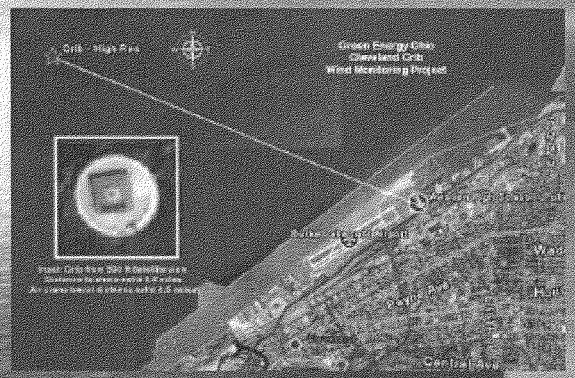
Verification of Predicted Wind Energy Resources



GLWEC PERMITTING TEMPLATE—MAJOR PROGRAMS

- FEDERAL
  - Army Corps of Engineers Construction Permit needed (Section 10 and/or 404 of Clean Water Act) – construction activities in lakes, rivers, streams, wetlands (33 CFR 320 to 330).
  - Construction Permit triggers National Environmental Policy Act (NEPA) and Environmental Assessment/Environmental Impact Statement Process.
  - Construction Permit also triggers need for Water Quality Certificate (Section 401 of CWA). Issued by Ohio EPA under delegated CWA authority.
  - Federal Endangered Species Consultation with US Fish and Wildlife service is tied into Construction Permit.
  - Consultation with Federal Aviation Administration depending upon proximity to airports to determine whether hazard to air traffic.
  - Coast Guard consultation re navigation issues.

PERMITTING TEMPLATE (CON'T)

- State of Ohio
- Department of Natural Resources (ODNR) consultations
  - Divisions of Wildlife review of habitat issues.
  - Division of Watercraft review of navigation issues.
  - Division of Geological Survey re foundations and structures.
  - Division of Coastal Management re submerged land leases and coastal impacts.
- Department of Transportation
  - Office of Aviation re potential aviation hazards. Cross reference to FAA review
- Ohio Power Siting Board
  - Approval required if electric generating facilities of at least 50 megawatts and electric transmission lines of 125kV or greater.

GLWEC Progress to Date

Identification of extensive wind energy supply chain manufacturing capability within Ohio

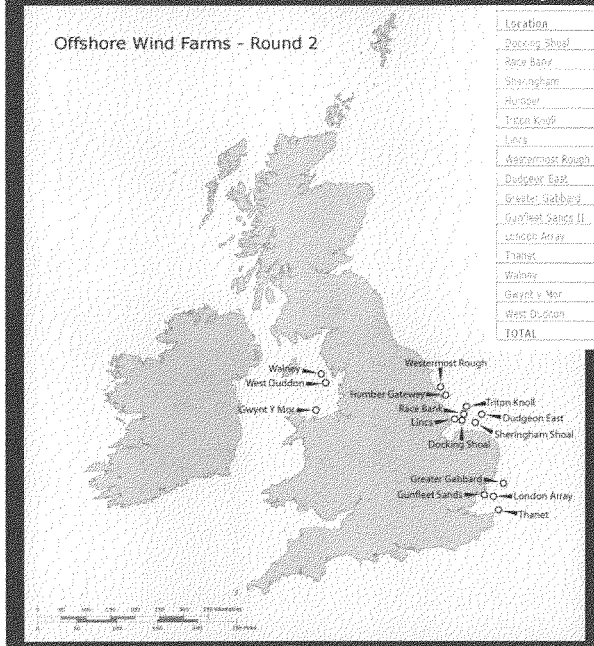
Data from 2-years of offshore wind measurements have verified the previously predicted potential for excellent wind in Lake Erie

All permitting and regulatory agencies have been engaged to develop an Environmental Assessment Plan for the Pilot Project

The award of $1,041,454 contract to juwi, Gmbh to conduct a feasibility study, which will be completed in April, 2008

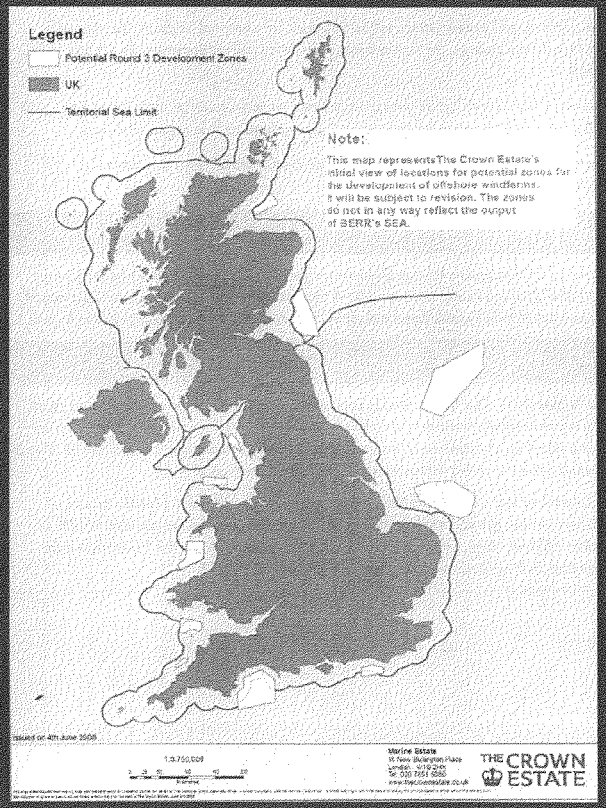
UK Offshore Wind Farms

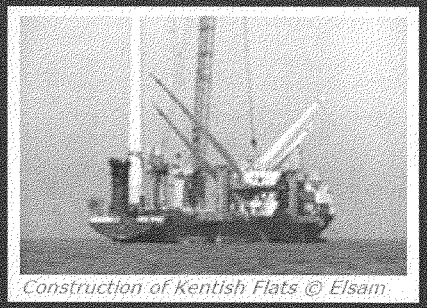
Round 2 Award Options issued 2003



Location	Maximum capacity (MW)	Developer
Docking Shoal	500	Centrica
Race Bank	580	Centrica
Sheringham	315	Ecoventures/Hydro/SP
Hunsper	300	Humber Wind
Triton Knoll	1,200	npower renewables
Lincs	250	Centrica
Westermost Rough	340	Total
Dudgeon East	300	Warwick Energy
Greater Gabbard	500	Airtricity/FPLor
Gunfleet Sands II	64	GE Energy
London Array	1,000	Energi E2 Farm Energy/Shell/ E.ON UK Renewables
Thanet	300	Warwick Energy
Walney	450	DONG
Gwynt y Mor	750	npower renewables
West Duddon	500	ScottishPower
TOTAL	7,169	

Potential UK Round 3 Locations





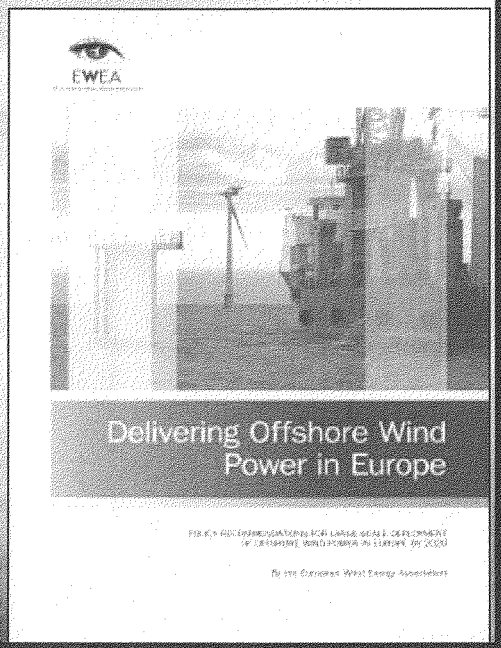
Construction of Kentish Flats @ Elsam

Norway Offshore Winds and Pumped Hydro: 8GW, $44 Billion by 2025

- OSLO, May 26, 2008 - Norway could become "Europe's battery" by developing huge sea-based wind parks costing up to $44 billion by 2025, Norway's Oil and Energy Minister said.
- Green exports could help the European Union reach a goal of getting 20 percent of its electricity by 2020 from renewable sources such as wind, solar, hydro or wave power.
- "Norway could be Europe's battery," Oil and Energy Minister Aaslaug Haga told Reuters after she was handed the report, which will be considered by the government in coming months.
- Haga said offshore wind parks -- which would stop on calm days -- could be supplemented by hydro-power reservoirs which can be turned on and off to turn them into a battery storing power. Norway has about half Europe's reservoir capacity.

POLICY RECOMMENDATIONS REPORT

The report intends to map out the potential development up to 2020, alongside an analysis of the issues and barriers surrounding the sector, and which must be addressed if the potential for offshore wind is to be tapped fully.



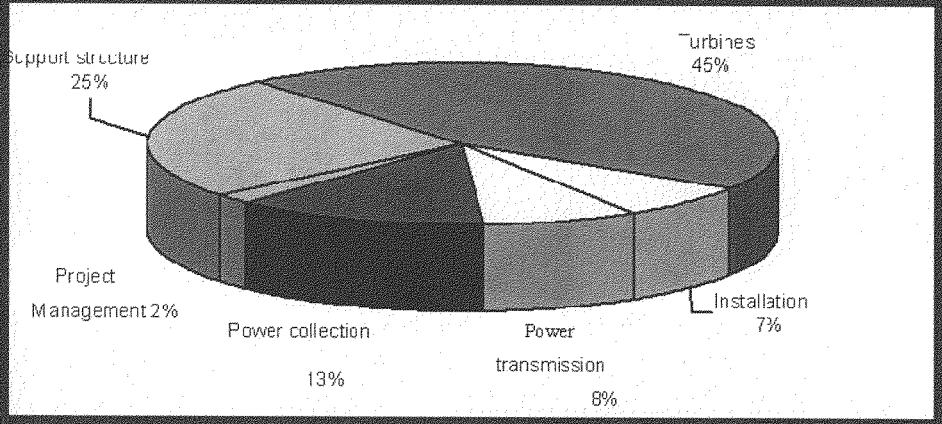
THE EUROPEAN COMMISSION

"Wind could contribute 12% of EU electricity by 2020. One third of this will more than likely come from offshore installations"

(Commission's Energy Package 10 January 2007)

Cost of Offshore Wind Dropping

Costs have been reduced by 25% from the first Danish offshore wind farms to the Horns Rev

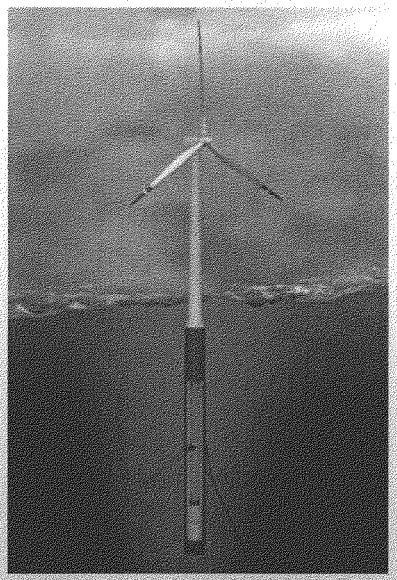


Benefits from Offshore Winds

Benefit	Basis	54-GW	78-GW
Energy Supplied	.4 cap factor	187.3 TWh	273.2 TWh
Percent of Current U.S. Electric Supply	3548 TWh consumed in 2004	5.3	7.7
Potential Jobs Created Construction Phase	39,000 job/yr/GW	2,110,680 job/yr	3,040,830 job/yr
Potential Jobs Created Permanent O&M	1,100 job/GW	59,532 jobs	85,767 jobs
Capital Invested	$1800/kW–$1600/kW	$97.4 billion	$124.8 billion
SO_x Avoided (metric tons/yr)	9.26 tons/yr/MW	501,151	722,002
NO_x Avoided (metric tons/yr)	3.29 tons/yr/MW	178,054	256,521
CO_2 Avoided (metric tons/yr)	3,281 tons/yr/MW	177,567,720	255,819,570

Walter Musial Data, NREL

HyWind Floating Wind Turbine Project
Spar – Ballast Stabilized



- Under development by StatoilHydro – Norway
- Needs 100-m+ depth to operate.
- Announced a $78MM demonstration project near Norway.
- Partnering with Siemens using their 2.3MW turbine.
- Costs estimated about where solar is today.
- Expectations to compete with conventional wind energy long term.

NREL National Renewable Energy Laboratory

Floating Wind Turbine Projections

- Technology will evolve from fixed bottom offshore experience.
- Floating wind turbine development must be developed as a full system with advanced engineering methods.
- Commercial floating wind systems will have optimized turbines to address platform motion, stability, weight, etc.
- Demonstration projects are needed to assess the technical issues and collect validation data.
- Commercial systems are years away but may be the endgame for wind power.

Demonstration of Two Deep Offshore 5MW Floating Wind Turbines in the Gulf of Maine

Draft 5/1/08 — 2008 Dollars

GENI Deploy / GENI Monitor — GENII Deploy / GENI Monitor — Commercial Offshore Wind Farm Construction: 1st GW, 2nd GW, 3d GW, 4th GW, 5th GW — GENI Retrieve — GEN II Retrieve

Task	Primary responsibility	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Total
1. Statewide site selection (analysis-based)	OEI, UM	350,000												350,000
Environmental, geophysical, wind, grid tie-in, distance as close as possible to wind farm sites														0
2. Site investigation	OEI, UM	450,000	350,000	350,000	350,000									1,500,000
Environmental, geophysical, wind														0
3. Permitting	OEI, UM	200,000	350,000		300,000	200,000								1,050,000
MMS or State, Environmental														0
4. Policy	UM, OEI	250,000	250,000	250,000	150,000	150,000								1,050,000
5. Communication	UM, OEI	350,000	300,000	250,000	200,000	150,000	150,000	150,000	150,000	150,000	150,000			2,000,000
6. Design for constructability (GEN I and GEN II)														0
Modeling: Structural, Hydrodynamics Aerodynamics	UM, BlueH	1,000,000	1,000,000											2,000,000
Advanced Composites, design and component testing	UM AEWC	3,800,000	3,200,000	4,000,000	3,900,000	2,200,000	500,000	500,000	500,000	500,000	500,000			19,700,000
Foundations	BlueH, UM	600,000	600,000	300,000	300,000									1,800,000
Constructability	Cianbro	250,000	250,000											500,000
Construction documents, plans and specifications	Cianbro	650,000	1,150,000											1,800,000
7. Construction, deployment GENI	Cianbro													0
Platform construction	Cianbro		10,500,000	10,500,000										21,000,000
Platform deployment (including blades)	Cianbro			4,000,000										4,000,000
Contingency	Cianbro		1,500,000	1,500,000										3,000,000
8. Construction, deployment GENII	Cianbro													0
Platform construction	Cianbro		10,500,000	10,500,000										21,000,000
Platform deployment (including blades)	Cianbro			4,000,000										4,000,000
Contingency	Cianbro		1,500,000	1,500,000										3,000,000
9. Certification	ABS	100,000	100,000		100,000	100,000								400,000
10. Advanced monitoring (5 years)	UMaine, OEI			2,400,000	1,500,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000				8,900,000
Environmental, fish, birds, mammals														0
Structural														0
mechanical														0
Power generation														0
11. Retrieval, salvage and disposal (optional)	Cianbro							2,000,000		2,000,000				4,000,000
Subtotal R&D, Demonstration		8,000,000	31,500,000	39,550,000	6,900,000	3,800,000	1,650,000	3,650,000	1,650,000	3,650,000	650,000			100,000,000
12. Major Wind Farms (Total of 5 GW)														
Planning, Design, financing, permitting/environmental	Private sector													
Construction, $3.5 billion/GW	UM, OEI	50,000	50,000	100,000	200,000	300,000	300,000	300,000	$3.5 billion	$3.5 billion	$3.5 billion	$3.5 billion	$3.5 billion	$17.5 billion

Global Markets Research

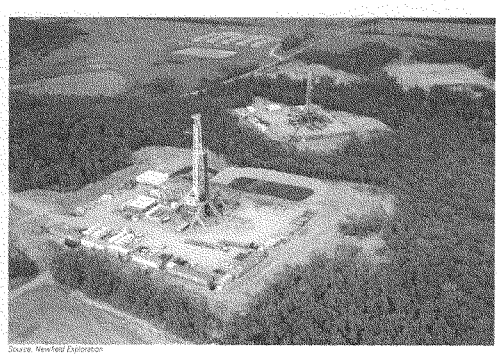
Company

North America United States
Industrials Oil & Gas Exploration & Production

22 July 2008

From Shale to Shining Shale

A primer on North American natural gas shale plays



Source: Newfield Exploration

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Deutsche Bank

FITT Research

Fundamental, Industry, Thematic, Thought-leading
Deutsche Bank Company Research's Research Product Committee has deemed this work F.I.T.T. for investors seeking differentiated investment themes and stock ideas. Here our E&P team examines shale gas, which we believe will be the country's #1 source of supply growth over the next decade.

Fundamental: we examine two dozen top North American shale gas plays

Industry: a shale play a day keeps investor doldrums away

Thematic: U.S. gas market likely to remain tight despite "wall of shale gas"

Thought leading: shale plays to motivate a wave of upstream M&A activity

Top picks offer significant shale acreage exposure and access to capital

North America United States
Industrials Oil & Gas Exploration & Production

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From Shale to Shining Shale

A primer on North American natural gas shale plays

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Fundamental: we examine two dozen top North American shale gas plays
After comparing acreage positions and growth plans for the various independent producers, we consider the implications of growing shale development for future U.S. natural gas supply/demand balances. We estimate shale plays currently represent 10% of daily U.S. natural gas production, and believe that percentage will double over the next three years.

Industry: a shale play a day keeps investor doldrums away
Splashy announcements and dramatic unveilings of new and "stealth" natural gas shale plays have abounded lately. Many new prospects seem destined to develop into large-scale, commercial drilling projects, but some of these early-stage plays may ultimately fail to meet economic thresholds. We delve into the Haynesville Shale, new on the scene in 2008, and conclude the play fully warrants all the hype. We see it becoming the country's largest gas field within the next 3-5 years.

Thematic: U.S. gas market likely to remain tight despite "wall of shale gas"
Barring a sudden turnaround in Canadian drilling activity or a global slump in demand, we believe that the U.S. will need incremental volumes arising from the shale drilling upswing. Even assuming ~5% U.S. gas production growth p.a., growing demand and falling Canadian net imports foster our reliance on foreign LNG. The firm outlook for U.S. natural gas prices underpins solid profitability for the domestic producers with attractive shale gas growth prospects.

Thought leading: shale plays to motivate a wave of upstream M&A activity
We believe most noted shale players are well positioned with respect to their current acreage exposure – yet not all have sufficient expertise and/or capital to commercialize these portfolios. Expensive front-end leasehold, drilling and infrastructure outlays, along with volatile commodity prices and capital markets, will pressure smaller players facing "drill it or lose it" lease expirations. We thus expect the shale theme to motivate the next wave of upstream M&A activity, as capital-rich producers who lack needle-moving shale exposure seek entry points.

Top picks offer significant shale acreage exposure and access to capital
We prefer to buy shares in mid-sized, well-capitalized producers offering largely self-funding assets and a measure of portfolio diversity, as they are more likely to "move the needle" for a large acquirer (but can also work even lacking a consolidation outcome). Our top picks are CHK, EQT, and RRC. We also highlight FST, PXD and XCO, as well as SWN and KWK, among others.

FITT Research

Top picks	
Chesapeake Energy (CHK.N),USD59.49	Buy
Range Resources (RRC.N),USD63.50	Buy
Forest Oil (FST.N),USD66.58	Buy
Pioneer Natural Resources (PXD.N),USD69.50	Buy
Equitable Resources (EQT.N),USD62.71	Buy

Companies featured	
Chesapeake Energy (CHK.N),USD59.49	Buy
Apache Corporation (APA.N),USD117.94	Hold
Anadarko Petroleum (APC.N),USD66.35	Hold
Bill Barrett Corporation (BBG.N),USD48.63	Buy
Continental Resources, Inc. (CLR.N),USD76.66	Hold
Delta Petroleum (DPTR.OQ),USD22.16	Buy
Devon Energy (DVN.N),USD106.19	Buy
EnCana Corp (ECA.N),USD82.98	Hold
EOG Resources (EOG.N),USD111.48	Hold
Equitable Resources (EQT.N),USD62.71	Buy
Forest Oil (FST.N),USD66.58	Buy
Goodrich Petroleum (GDP.N),USD69.51	Hold
Quicksilver Resources (KWK.N),USD34.80	Buy
Noble Energy (NBL.N),USD86.09	Hold
Newfield Exploration (NFX.N),USD56.93	Hold
Pioneer Natural Resources (PXD.N),USD69.50	Buy
Range Resources (RRC.N),USD63.50	Buy
SandRidge Energy, Inc (SD.N),USD59.01	Hold
Southwestern Energy Co. (SWN.N),USD40.85	Buy
Ultra Petroleum (UPL.N),USD80.05	Buy
Exco Resources (XCO.N),USD35.28	Buy
XTO Energy (XTO.N),USD58.27	Buy

Table of Contents

Executive summary

Outlook: shale, the dominant source of U.S. gas supply to come

Hype, yes – but we actually view the heavy focus on gas shales as very well placed

To date, 2008 has brought a series of splashy announcements and dramatic unveilings of new and "stealth" North American shale plays, driving significant differential share price performance for the operators involved. For all the seeming hype, we actually believe this heavy focus on gas shales is very well-placed: we estimate that shales currently account for 10% of total U.S. gas production, and believe that percentage can double within the next three years. In fact, we believe shale gas will be the country's #1 source of supply growth over the next decade.

We have five main goals in this report:

- We present capsule summaries on each of about two dozen North American shale gas plays. We divide them into three basic groups: established or commercially producing shales; emerging/developing shales; and exploration-stage plays.
- In addition, we scrutinize the individual play economics for several leading shales, to compare and contrast "type well" rates of return and indicative finding costs, among other metrics.
- We offer an extensive database detailing the acreage position and current shale-related activities of over 60 publicly traded independent E&P companies.
- We probe one featured shale of heightened current interest, the Haynesville, and offer a preview of up-and-coming shale plays in the Rockies.
- Finally, we close with an analysis of how all these shales will fit within the U.S. supply/demand picture.

Demand growth and reduced net imports should keep U.S. natural gas prices strong despite anticipated increments from shale gas over the next 3-5 years

We conclude that, barring a sudden turnaround in Canadian drilling activity or a widespread global recession that reduces demand for natural gas worldwide, the U.S. will need the incremental volumes that are likely to be generated from the current upswing in shale drilling activity. Even assuming ~5% U.S. gas production growth per annum, our reliance on foreign LNG is expected to rise to record levels amid growing demand and falling Canadian net imports over the next several years. This should keep U.S. natural gas prices strong, underpinning solid profitability for the domestic producers with attractive shale gas growth prospects.

Top picks and valuation methodology

CHK, EQT and RRC—the sector's top three shale leaseholders per our calculations—remain top picks, offering more than 40% appreciation potential to our NAV-derived target prices (see coverage list, page 24)

The top three shale leaseholders in the U.S., per our calculations, are all Buy-rated top picks:

- **Chesapeake Energy (CHK):** 4.2MM net acres spread across nine distinct plays,
- **Equitable Resources (EQT):** 3.5MM over three plays concentrated in Appalachia,
- **Range Resources (RRC):** 1.7MM acres over seven plays.

In addition, we see two other attractively valued, Buy-rated plays on the Haynesville Shale among others:

- **Forest Oil (FST):** 90,000 net acres in the Haynesville and interesting exposure to the emerging Utica Shale in Quebec

- **EXCO Resources (XCO):** 107,000 net acres in the Haynesville, with announced JV catalysts pending

Other Buy-rated stocks with shale exposure include:

- **Bill Barrett Corp. (BBG):** a "pure play" Rockies producer with several announced shale initiatives and, we believe, others up its sleeve
- **Devon Energy (DVN):** an attractively-valued large-cap shale expert that has been surprisingly "mum" about its probable Haynesville initiatives...so far
- **Pioneer Natural Resources (PXD):** while not a traditional "shale" operator, it is working on a promising new gas play in the Raton Basin – the Pierre Shale
- **Quicksilver (KWK):** offers exposure to the proven Barnett Shale along with longer-term upside in the Horn River Basin, British Columbia
- **Southwestern Energy (SWN):** the "2,000 pound gorilla" in the Fayetteville Shale, the company also has footholds in a few other emerging shales
- **Ultra Petroleum (UPL):** better known for its enviable Pinedale Anticline tight gas asset, Ultra has initiated a program in the Appalachian Marcellus Shale
- **XTO Energy (XTO):** a high-quality larger cap play offering diversified exposure to a number of domestic gas (and oil) shale plays.

Our E&P price targets are set according to our prospective NAV estimates, which incorporate PV-10 values for proved reserves, along with estimated possible and probable reserves on a risked basis net of debt.

Risks: weakening consumption, supply anomalies, politicking

Our bullish thesis on shale gas rests upon relatively robust demand fundamentals in the U.S. and elsewhere. An unexpected decline in gas consumption, either due to prolonged mild weather patterns or a global recession, poses a major risk to our thesis.

Also, "lumpy" or faster-than-expected growth in shale supplies could leave the U.S. in temporary imbalance at times until its ability to export gas improves.

In addition, while environmentally-friendly natural gas would seem to be a preferred fuel over the next decade, E&P companies are exposed to drilling risks and regulatory and environmental delays amid an increasingly inhospitable domestic political backdrop for energy producers generally.

Shale: the basics

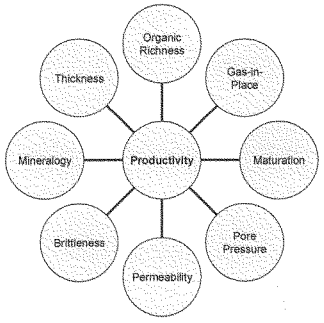
What is shale gas?

By definition, shale gas is an unconventional, continuous natural gas reservoir contained within fine-grained rocks, dominated by shale. Shale is the earth's most common sedimentary rock, rich in organic carbon but characterized by ultra-low permeability. In many fields, shale forms the seal that retains the hydrocarbons within producing reservoirs, but in a handful of basins shale forms *both* the source and reservoir for natural gas.

While shale gas is typically difficult to extract given the rock's low permeability, it typically produces "clean." The reservoir has been sufficiently heated over time to break down any liquid hydrocarbons. *Thermal maturity* (commonly abbreviated Ro) is a measurement indicating how long a reservoir has been heated—more thermally mature shales (0.6-2.0% Ro) tend to contain dry gas, while less mature shales (0.4-0.6% Ro) contain mostly or all oil. For purposes of this report, we focus on the more thermally-mature gas shales, but in future research we will expand the discussion to *oil shales*, such as the booming Bakken shale of Montana and North Dakota.

Since shale wells are characterized by low permeability, after a flush initial flow they tend to decline steeply, and the remaining gas produces very slowly over time. The steep hyperbolic initial decline (typically 65-75% in the first year) flattens out by the third or fourth year, after which shale wells will produce at relatively low rates for decades. Estimated ultimate recoveries of the original gas in place (OGIP) are typically only around 20%, much lower than conventional gas plays, but recovery factors are continually improving with advances in completion and horizontal drilling. *Figure 1 illustrates the elements of a successful shale gas play.*

Figure 1: Elements of a successful shale gas play



Source: Colorado School of Mines

Horizontal drilling and completion techniques

Vertical drilling is typically used in the initial or pilot-testing phases of an emerging shale play, given the lower cost of coring and drilling vertically. However, once a shale play is deemed to be commercially viable based on early testing, almost without exception wide-scale development is undertaken using horizontal drilling. In a horizontal well, a vertical well is deviated to drill laterally, so as to expose the wellbore to the maximum amount of the shale formation as possible. Also, in many instances the naturally-occurring fractures in the shale are oriented vertically, so a horizontal well effectively intersects these pre-existing fractures, increasing potential production rates.

In most cases, a successful shale gas well requires hydraulic stimulation. When completing a shale well, an operator will commonly perform numerous staged fracture jobs along the lateral leg of the wellbore—that which is in direct contact with the producing shale zone. In each frac "stage," fluid and proppant (grains of synthetic materials or sand used to prop porespace open) is hydraulically pumped into perforations that are "punched" into a section of the formation. After each stage, a plug is set and the process is repeated, moving up the wellbore. While the theoretically ideal completion would involve the maximum possible smaller frac stages—so as to contact the maximum amount of rock in the wellbore—that quickly becomes cost-prohibitive. While every shale is different and completion methods can vary widely between operators, we most commonly hear about lateral lengths of 3-6,000 feet with frac stages performed every 500-700 feet.

"Size of the prize" – Jumbo

The Gas Technology Institute estimates that gas-in-place within U.S. gas shales ranges from 500-780 Tcf. In a 2007 unconventional gas article, the Oil and Gas Journal estimated 128 Tcf in *recoverable* resources from gas shales in the U.S. While impressive, these figures strike us as low estimates, likely because they were published prior to the recent unveiling of the Haynesville Shale, and probably underestimated the pace of performance improvement in emerging shales such as the Appalachian Marcellus, Fayetteville and Woodford.

We estimate that shales currently account for 10% of total U.S. gas production, and believe that percentage will double within the next three years.

As Figure 2 indicates, only one of the top 10 onshore gas fields in the U.S. currently produces purely from gas shale; however, this is rapidly changing. Several emerging shale plays seem poised for explosive growth over the next 2-3 years. A November 2002 AAPG paper stated that the Antrim Shale of Michigan and the Devonian Shales of the Appalachian basin accounted for about 84% of the total U.S. shale gas production in 1999-2000, which totaled roughly 1 Bcf/d. Today, the Barnett Shale alone produces four times that daily rate, and other shales appear to be on a very rapid growth track as well. *We estimate that shales currently account for 10% of total U.S. gas production, and believe that percentage will double within the next three years.*

Figure 2: Top 10 onshore gas fields

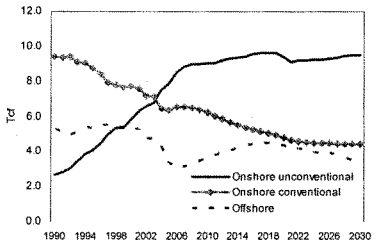
		States	Type	2006 prod'n (Bcf)	Discovery date
1	San Juan Basin gas area	CO & NM	CBM	1380.8	1927
2	Newark East/ Barnett Shale	TX	Shale	716.7	1981
3	Pinedale	WY	Tight gas	236.7	1955
4	Hugoton gas area	KS & OK & TX	Tight gas	342.0	1922
5	Jonah	WY	Tight gas	292.5	1977
6	Natural Buttes	UT	Tight gas	166.0	1940
7	Waltenberg	CO	Tight gas	176.0	1970
8	Raton Basin gas area	CO & NM	CBM	109.6	1998
9	Madden	WY	Tight gas	157.9	1968
10	Powder River Basin CBM	WY	CBM	377.0	1992

Source: Energy Information Administration (U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2006 Annual Report), issued 12/31/07

Since the data in Figure 2 was compiled by the EIA in late 2007, we estimate that the Barnett Shale has already assumed the #1 spot, based on current fieldwide production estimated approaching 4 Bcf/d. Given the early promise of the Haynesville Shale of northwestern Louisiana, we believe that play will occupy a top spot on top 10 list (if not *the* top spot) within a matter of years. For its part, Chesapeake Energy expects 250 Tcfe of recoverable reserves from over 700 Tcf of gas in-place in the Haynesville Shale, roughly five times the size of Barnett. CEO Aubrey McClendon stated in an early-July conference call that the Haynesville Shale is likely to become America's largest natural gas field and perhaps the fourth largest in the world.

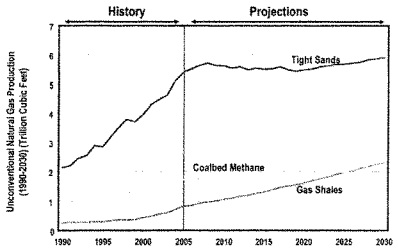
We believe that the Marcellus Shale, and further out the Horn River Basin Muskwa/Ootla shale in British Columbia, could rival or trump the Barnett Shale in production and reserves. *These and other shale plays will be examined in detail within this report.* We estimate that the top ten onshore gas fields listed in Figure 2 account for nearly 25% of daily gas production in the U.S., and believe "big fields," including shales, will continue to account for a growing share of an otherwise-mature North American producing basin (see Figure 3 and Figure 4).

Figure 3: Unconventional sources driving supply growth



Source: EIA, AEO 2008

Figure 4: Shales to dominate L-48 production growth



Source: EIA AEO 2007

Shales gone wild

To date, 2008 has been the year of splashy announcements and dramatic unveilings of new and "stealth" North American shale plays. Most of these were very well-received by Wall Street. For starters, EOG Resources held its annual analyst meeting on February 28th, divulging that it holds a 140,000-acre position in the Muskwa/Ootla Devonian Shale play in the Horn River Basin of northeastern British Columbia. Citing 6 Tcfe of net potential based on three vertical and three horizontal wells drilled to date, EOG's shares enjoyed a 15% ($4.7 billion) one-day markup in equity market capitalization as investors applauded this and a handful of other new play announcements. We calculate this move represented a value-add of $0.44/Mcfe based on the high-end 10.7 Tcfe of total company-estimated unrisked resource potential disclosed that day. Interestingly, the Muskwa/Ootla Shale had been previously publicly-discussed (albeit with much less fanfare) by other large-cap competitors already active in the play, including Apache and EnCana.

Chesapeake Energy then hit the market in late March with its own blockbuster play announcement. The company revealed a 200,000-acre position in the Haynesville/Bossier Shale of Northwestern Louisiana, validating Petrohawk's claims earlier that month that this was the "new shale to watch." Chesapeake issued a net potential estimate of 7.5 Tcfe based on the results from seven recent vertical and horizontal wells, along with roughly two years of petrophysical analysis and other regional technical work. Soon after, on April 1st, Forest Oil, not a producer that has been particularly known for a longstanding focus on unconventional resources, revealed a 269,000 acre position in the shallow Utica Shale in the St. Lawrence Lowlands of Quebec, Canada, citing 4 Tcfe of net potential based on two vertical well tests to date. Despite the lack of horizontal test data and any known third-party data on the play, Forest's shares jumped 7.2% ($312MM) on the day of the announcement, and continued to outperform in the days following. The recent focus on FST's 90,000 net acre position in the Haynesville Shale has kept generally steady upward pressure on the shares.

While we believe much of this enthusiasm is justified, we recognize the risk inherent in extrapolating a limited number of drilling datapoints into a playwide estimate of resource potential. Even after a play is deemed to be commercially viable, the keys to economic development (just as with most unconventional or "continuous" gas accumulations) are first, possessing a large expanse of prospective acreage, and second, executing a wide-scale drilling program akin to a "manufacturing process" that can capture scale efficiencies and deliver reliable and consistent results. Neither of these can be oversimplified in today's hyper-competitive domestic upstream environment.

A handful of pilot tests may or may not be sufficient to demonstrate continuity of a gas resource across dozens/hundreds of miles or to definitively prove that sufficient petrophysical characteristics are present for commercial production. Thus, we place a fairly heavy risk factor on these new potential resources within our prospective NAV models, often assuming a 25% chance of success or lower. However, we concede that even this treatment is quite arbitrary given the difficulties inherent in discerning how much evidence "is enough."

We lean heavily on each company's track record, not just based on similar past announcements to judge management credibility and execution capabilities, but on the company's accumulated experience with shale plays themselves, as it does appear that many shales have similar petrophysical characteristics and can be used by analogy for preliminary assessment purposes.

Gas shales "play by play"

A bottom-up view

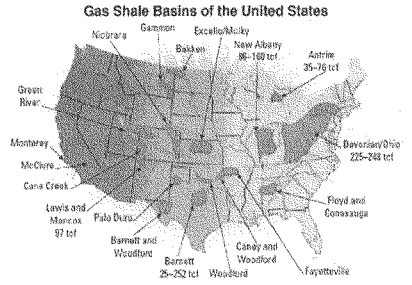
Beginning in Appendix A, we present a capsule summary on each of about two-dozen North American shale gas plays. We divide them into three basic groups: established, or commercially producing shales; emerging/developing shales; and exploration-stage plays. We classified "established" shales as those with sufficient production history and/or public data to support "type well" decline analysis, and we include a host of technical datapoints for comparison purposes. For the emerging/developing and exploration-stage plays, we provide technical details to the extent known via publicly-available data. While the collection of shale plays we present is not intended to be an exhaustive list, it is a solid jumping-off point to which we will add future discussion as new shale plays emerge. We summarize the petrophysical and economic data in Figure 7.

Figure 5: Shale plays explored in this report (see full data in Appendix A)

ESTABLISHED Commercially producing	EMERGING/DEVELOPING Progressing toward commerciality	EXPLORATORY Initial testing underway
Antrim (Michigan)	Haynesville (N LA/ E TX)	Baxter/Hilliard (Vermilion Basin, WY/CO)
Barnett (Core/"Tier 1")	Horn River Basin Muskwa/Otla (NE British Columbia)	Chattanooga (Arkansas/Tennessee)
Barnett (Southern & western counties)	Marcellus (Pennsylvania)	Cody (Montana)
Devonian (underpressured) (Appalachia)	Montney (BC, Canada)	Delaware Basin Barnett/Woodford (West Texas)
Fayetteville (Arkansas)	Pearsall (Maverick Basin, TX)	Floyd/Conasauga (Mississippi and Alabama)
New Albany (IL / IN)		Gothic/Hovenweep (Paradox Basin, Utah and Colorado)
Woodford (Oklahoma)		Lewis (Wyoming)
		Mancos (Uinta Basin, UT)
		Pierre/Niobrara (Colorado)
		Utica (PA/NY deep and Quebec, Canada shallow)

Source: Deutsche Bank

Figure 6: Gas shale locator map



Source: American Association of Petroleum Geologists (AAPG)

Figure 7: Summary petrophysical and economic parameters for top North American gas shale plays

	Depth range (ft)	Shale thickness (ft)	GIP/sq mi (Bcf)	Porosity	Total organic carbon (TOC)	Thermal maturity (Ro)	Press. gradient (psi/ft)
Antrim Shale	600-2,200	160	6-15	9.0%	1-20%	0.4-0.6%	0.35
Barnett Shale (Core/"Tier 1" incl. Johnson Cty)	6,500-9,000	100-500	50-200; avg 150	4-6%	3.5-8%	2.2%	0.46-0.52
Barnett Shale (South/Western Counties)	6,500-9,000	100-250	50-125	3-4.8%	3.5-5%	2.2%	0.46-0.52
Baxter/Hillard Shale	10,000-19,500	2,850-3,300	440	3-5.5%	1-2.5%		
Chattanooga Shale	1,600-4,000	35-200			4.6%		
Cody Shale	5-6,000	500-1,000					
Delaware Basin Barnett/Woodford Shale	5,100-15,300	4-800 (B); 125-350 (W)	50-300		4-7%		
Devonian Shales (Huron, Cleveland, Rhinestreet)	1,600-6,000	50-300	5	6-14%	1-6.5%	0.6-2.0%	
Fayetteville Shale	1,500-6,500	20-200	25-65	2-8%	4-9.5%	1.5-4.0%	0.44
Floyd/Neal & Conasauga Shales	6,000-10,000	80-180		1.6%	1.8%		
Gothic/Hovenweep Shales	5,500-7,500	80-150					
Haynesville Shale (aka Bossier Shale)	10,500-13,500	200-240	150-250	8-12%	3-5%		0.7-0.9
Lewis Shale	3-6,000	500-2,000	8-90	3-5.5%	1-2.5%	1.6-1.9%	0.20-0.25
Mancos Shale	13-17,500	3,000	280-350	2-5%	1%		0.66
Marcellus Shale	5,000-8,500	50-200	70-150	6.0%	2-10%	1.0-2.5%	0.4-0.7
Montney Shale	6,600-8,200	950+	75-100	6.0%			
Muskwa/Ootla Devonian Shale	7,800-13,300	360-580	180-320	4.0%	3%	2.8%	
New Albany Shale	1,000-4,500	100-300	8-20	10-14%	1-25%	0.4-1.0%	0.43
Pearsall & Eagleford Shales	6,000-11,500	600-700	100-300				
Pierre/Niobrara Shales	4,000-6,000	2,200-2,800	100	2-6%	1.6-2.6%	2.0-2.8%	
Utica Shale (deep)	12-15,000	100-400					
Utica Shale (shallow)	2,300-6,000	500	93	3.5%	1-3%	1.3-2.0%	0.45-0.60
Woodford Shale	6,000-13,000	150 (Ark); 345 (Ard)	40-120 (Ark); 220-300 (Ard)	6-8%	3-10%	1.1-3.0%	0.52

	Expected RI	Lateral lengths (ft)	IP rates (MMcf/d)	Expected EUR per well, Bcfe	Average well cost ($MM)	Expected F&D/Mcfe	Typical well spacing (acres/well)
Antrim Shale	20-60%		0.04-0.3	0.2-1.2	$0.3-0.5	$0.70	40-80
Barnett Shale (Core/"Tier 1" incl. Johnson Cty)	20-50%	2,500-3,000	2-12	2-9 (Avg. 3)	$2-3	$0.80-1.30	25-50
Barnett Shale (South/Western Counties)	20%	2,700-2,800	1.2-4.7	1-3	$1.6-3.7	$1.80-2.10	50-100
Baxter/Hillard Shale	10%	3-4,000	10+	20	$20.0		40-160
Chattanooga Shale		3,000	0.3-5		$1.1		
Cody Shale					$3.0		
Delaware Basin Barnett/Woodford Shale				3	$6.5	$2.50	160
Devonian Shales (Huron, Cleveland, Rhinestreet)	20-50%	3500	0.2-1.0	1-2.2	$0.5-3.0	$1.30	80
Fayetteville Shale	20-40%	1,500-5,000	2-4	2-3	$1.75-3.05	$1.00-1.75	40-80
Floyd/Neal & Conasauga Shales			< 1	< 1	$3.0	$3.50	320
Gothic/Hovenweep Shales		1,500-3,500		1-3	$3.8-5.0		
Haynesville Shale (aka Bossier Shale)	30%	4,000	8+	4.5-8.5	$6-7	$1.00-$1.50	60-80
Lewis Shale	5-15%			.05-2.0			80
Mancos Shale	5-15%		1-2 (Mancos only)	3-6*	4-8	$2.00	40-80
Marcellus Shale	20-40%	2500	2.6-5.8	3.5	$3-4	$0.90-$1.60	80-160
Montney Shale	up to 50%	5000	5-10	2.5	$4-6	$2-2.50	80-160
Muskwa/Ootla Devonian Shale	20-30%	4,600-8,200	5-10	4-6	$7-10	$2.00	40
New Albany Shale	10-20%	3-4,000	2	1.0-1.1	$0.8-1.0	$1.00	320
Pearsall & Eagleford Shales			1				
Pierre/Niobrara Shales	16%					$1.65-2.50	80
Utica Shale (deep)							
Utica Shale (shallow)	20%	2000		1.3-2.2	$2.5 - $4	$2-2.10	100
Woodford Shale	60%+	2,400-5,000	3-12	3.0-5.0	$4.6-8	$1.75-2.00	40-80

Note: blank values indicate unknown or unavailable datapoints

* Note: Reflects EUR for entire section including Dakota, Mancos, Blackhawk, Mesaverde and Wasatch. Mancos standalone contribution is ~1-1.5 Bcfe.

Source: Wood Mackenzie, EIA/DOE, USGS, company data, Deutsche Bank estimates

Comparative shale play economics for five leading shales

We have built out "type-curve" analyses for a handful of high-profile established and emerging shale plays to compare and contrast expected well economics. Figure 8 below lays out our key assumptions and the findings that flow from each individual type curve model. As shown, we have separated the Barnett into "Core" and "Noncore" regions given the variance in the type-well economics demonstrated by the active operators to date.

Figure 8: Summary Shale production and economic parameters

NYMEX gas price assumption: $9.00

	Barnett Core	Barnett Noncore	Fayetteville	Haynesville	Marcellus	Woodford
ASSUMPTIONS						
IP, MMcf/d	4.0	2.0	2.0	10.0	3.0	4.5
1st yr decl	68%	65%	62%	80%	65%	66%
2nd yr decl	23%	20%	33%	30%	30%	35%
3rd yr decl	15%	15%	15%	15%	15%	15%
Terminal decl	10%	10%	10%	10%	10%	10%
Initial well cost, MM	$ 3.10	$ 3.10	$ 3.20	$ 7.00	$ 3.75	$ 6.70
Realized price/Mcf	$ 8.50	$ 8.50	$ 8.50	$ 9.00	$ 9.30	$ 8.25
Operating cost/Mcf	$ 1.85	$ 1.85	$ 1.30	$ 1.50	$ 0.90	$ 1.25
Royalty Rate	25%	25%	13%	25%	15%	27%
Leasehold cost/acre	25,000	10,000	5,000	25,000	2,500	6,500
OUTPUTS						
EUR (Bcfe/well)	4.3	2.4	2.3	7.0	3.3	4.5
IRR	64%	31%	47%	69%	86%	33%
F&D cost/Mcfe	$ 1.26	$ 1.94	$ 1.82	$ 1.71	$ 1.42	$ 2.18
NPV/Mcfe	$ 1.71	$ 1.17	$ 2.03	$ 2.01	$ 2.93	$ 1.27
NPV/acre	$ 185,491	$ 70,036	$ 57,456	$ 175,606	$ 119,756	$ 72,090
Breakeven gas px*	$ 5.12	$ 6.32	$ 5.07	$ 4.73	$ 3.17	$ 6.11

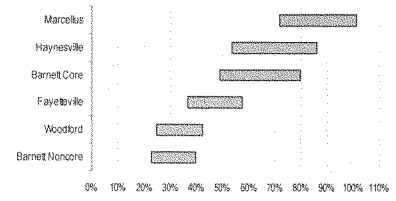
* NYMEX; for a 10% pretax IRR

Source: Deutsche Bank estimates

We believe the Marcellus Shale offers the most attractive range of IRRs on a type-well basis, due to broadly lower royalties in Appalachia and premium natural gas pricing

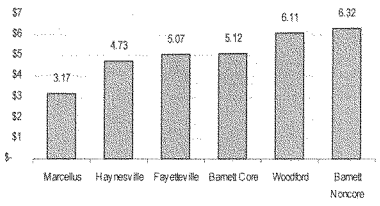
We also ran type well economics assuming natural gas prices ranging from $8/MMbtu to $10/MMbtu, to generate the IRR ranges illustrated below in Figure 9. Our type-well economics indicate that (perhaps contrary to current consensus views) the Marcellus Shale appears to offer the most attractive range of IRRs on a type well basis (72-100%), benefiting from broadly lower royalties in the region and premium natural gas pricing given the play's proximity to populous consuming markets. The emerging Haynesville Shale appears to follow a close second at 54-86%, though we point out our 80% initial decline rate assumption (year 1) is arguably more onerous than the play leader Chesapeake has cited. We are sticking with modestly conservative assumptions on that play for the time being given the very limited data available on this nascent play (please see our full Haynesville Shale discussion beginning on page 14 for more). The Barnett (core area) ranks third with indicative IRRs of 49-80%, while the Fayetteville, Woodford and Barnett noncore areas fall in somewhat lower ranges.

Figure 9: Pretax IRRs at $8-$10/MMBtu NYMEX gas



Source: Deutsche Bank estimates

Figure 10: Breakeven economics ($/MMBtu*)



Source: Deutsche Bank estimates. * NYMEX for a 10% pretax IRR

Economics of Marcellus and Haynesville Shale wells remain robust down to very low breakeven prices of $3.17 and $4.73/MMbtu, respectively

Figure 10 depicts the NYMEX natural gas prices required to drive the individual plays' returns down to a 10% weighted average cost of capital. Here again Marcellus and Haynesville lead the pack, with very low breakeven prices of $3.17 and $4.73/MMbtu, respectively. The Fayetteville and Barnett Core area settled out in the $5/MMbtu area, while the Barnett noncore and Woodford appear comparable at ranges moderately above $6/MMbtu. Notably, we believe the six plays we analyzed represent the "best of breed" among U.S. shale plays, and would not expect most other shale and tight gas plays to stack up to these strong metrics.

Top three E&P sector shale leaseholders: CHK, EQT and RRC

"Million Acre Club" includes eleven E&P companies

Figure 11 lists the E&P sector's top shale participants, ranked by net shale leasehold ownership (note that we exclude privately-held and larger integrated oil and gas entities from this listing, and have focused on U.S.-domiciled entities). While likely not an exhaustive list, we have done our best to tally up the most recent announced net shale acreage positions for the publicly-traded E&P companies that regularly provide this type of data. Play-by-play breakdowns are presented within Appendix A.

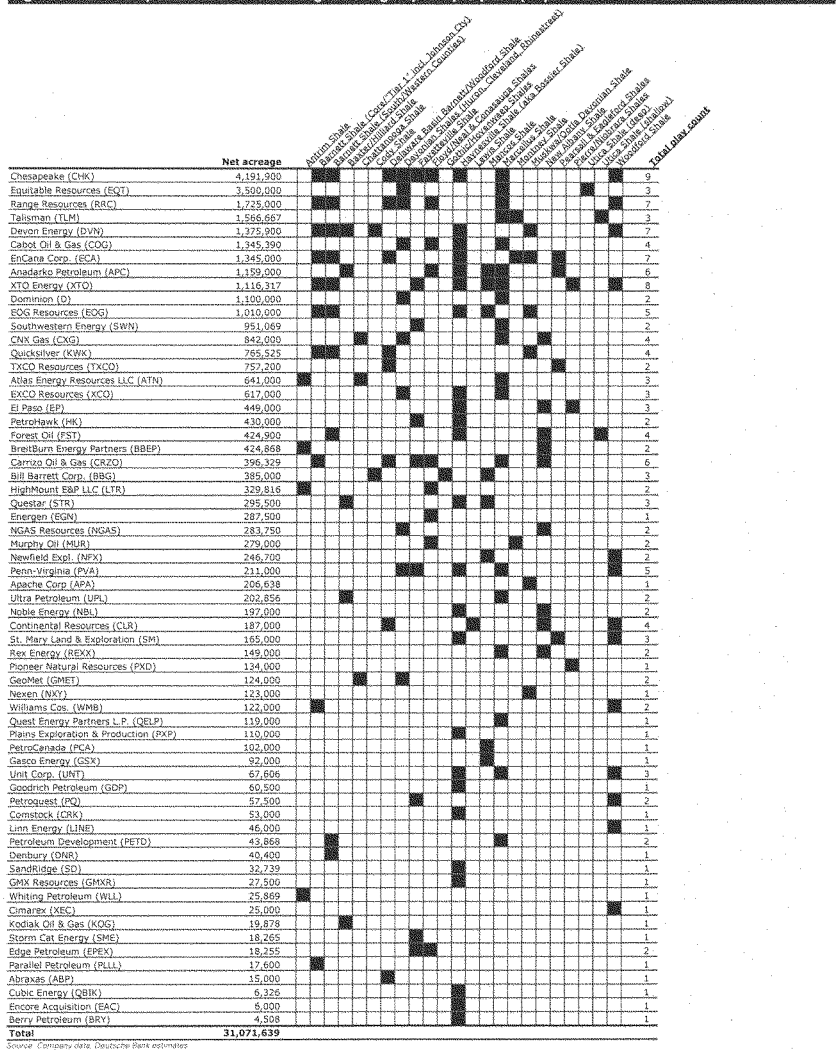
The top ten acreage holders control more than 60% of the shale leasehold encompassed in our survey

Our top three picks on the list of top shale participants are:

- Buy-rated Chesapeake Energy (4.2MM net acres spread across nine distinct plays),
- Equitable Resources (3.5MM over 3 plays), and
- Range Resources (1.7MM acres over 7 plays).

The next eight participants, all of which hold more than 1MM acres, include Talisman, Devon Energy, Cabot Oil & Gas, EnCana Corp., Anadarko Petroleum, XTO Energy, Dominion and EOG Resources. *The top ten leaseholders on this list control more than 60% of the shale leasehold encompassed in our survey.*

Figure 11: Summary North American shale gas acreage by company and play



	Net acreage	Total play count
Chesapeake (CHK)	4,191,900	9
Equitable Resources (EQT)	3,500,000	3
Range Resources (RRC)	1,725,000	7
Talisman (TLM)	1,566,667	3
Devon Energy (DVN)	1,375,900	7
Cabot Oil & Gas (COG)	1,345,390	4
EnCana Corp. (ECA)	1,345,000	7
Anadarko Petroleum (APC)	1,159,000	6
XTO Energy (XTO)	1,116,317	8
Dominion (D)	1,100,000	2
EOG Resources (EOG)	1,010,000	5
Southwestern Energy (SWN)	951,069	2
CNX Gas (CXG)	842,000	4
Quicksilver (KWK)	765,525	4
TXCO Resources (TXCO)	757,200	2
Atlas Energy Resources LLC (ATN)	641,000	3
EXCO Resources (XCO)	617,000	3
El Paso (EP)	449,000	3
PetroHawk (HK)	430,000	2
Forest Oil (FST)	424,900	4
BreitBurn Energy Partners (BBEP)	424,868	2
Carrizo Oil & Gas (CRZO)	396,329	6
Bill Barrett Corp. (BBG)	385,000	3
HighMount E&P LLC (LTR)	329,816	2
Questar (STR)	295,500	3
Energen (EGN)	287,500	1
NGAS Resources (NGAS)	283,750	2
Murphy Oil (MUR)	279,000	2
Newfield Expl. (NFX)	246,700	2
Penn-Virginia (PVA)	211,000	5
Apache Corp (APA)	206,638	1
Ultra Petroleum (UPL)	202,856	2
Noble Energy (NBL)	197,000	2
Continental Resources (CLR)	187,000	4
St. Mary Land & Exploration (SM)	165,000	3
Rex Energy (REXX)	149,000	2
Pioneer Natural Resources (PXD)	134,000	1
GeoMet (GMET)	124,000	2
Nexen (NXY)	123,000	1
Williams Cos. (WMB)	122,000	2
Quest Energy Partners L.P. (QELP)	119,000	1
Plains Exploration & Production (PXP)	110,000	1
PetroCanada (PCA)	102,000	1
Gasco Energy (GSX)	92,000	1
Unit Corp. (UNT)	67,606	3
Goodrich Petroleum (GDP)	60,500	1
Petroquest (PQ)	57,500	2
Comstock (CRK)	53,000	1
Linn Energy (LINE)	46,000	1
Petroleum Development (PETD)	43,868	2
Denbury (DNR)	40,400	1
SandRidge (SD)	32,739	1
GMX Resources (GMXR)	27,500	1
Whiting Petroleum (WLL)	25,869	1
Cimarex (XEC)	25,000	1
Kodiak Oil & Gas (KOG)	19,878	1
Storm Cat Energy (SME)	18,265	1
Edge Petroleum (EPEX)	18,255	2
Parallel Petroleum (PLLL)	17,600	1
Abraxas (ABP)	15,000	1
Cubic Energy (QBIK)	6,326	1
Encore Acquisition (EAC)	6,000	1
Berry Petroleum (BRY)	4,508	1
Total	**31,071,639**	

Source: Company data, Deutsche Bank estimates

Focus play: Haynesville Shale

Got Haynesville? Drilling down on a red-hot emerging shale play

A major new gas discovery in Northwestern Louisiana has taken the sector by storm, driving substantial share price outperformance for the publicly-traded participants to date this year. The Haynesville is a rich organic shale deposit located between the Bossier and Smackover formations at depths ranging from 10-13,000 feet. The Haynesville is the source rock to the prolific Cotton Valley and Hosston formations, and preliminarily appears to be prospective over a broad region in Northwestern Louisiana and likely, East Texas (see map below, Figure 12). The "core area" of the Haynesville Shale presently centers on or around Caddo, De Soto, Red River, and Bossier parishes in Northwest Louisiana. The publicly-traded leaseholders we have identified (discussed later) represent about 2.2 million acres of aggregate ownership out of the 3.5 million acre play fairway, as presently defined.

Figure 12: Haynesville Shale locator map

Source: WoodMackenzie

The shale is highly overpressured in the southern portion of the play. Shale thicknesses are estimated at 200 feet or more in the better areas. The Haynesville has limited faulting, and higher porosity than the Barnett. Unfortunately, more detailed petrophysical information on the Haynesville (such as silica content and total organic carbon) is not readily available, but shale specialists like Chesapeake Energy have ostensibly carefully studied the Haynesville's rock properties over the past two years, and its aggressive investments in the play to date speak volumes as to its confidence in shale's production capabilities. WoodMackenzie estimates recovery factors will be roughly 30% of gas-in-place, which is believed to range from 200-250 Bcf per section.

In March 2008, Chesapeake stated the Haynesville Shale could be the most important asset in the company's 19-year history

While the Haynesville Shale was first publicly unveiled in early March by Petrohawk (HK, not covered) at its annual analyst meeting, it was in fact Chesapeake's March 24th announcement that set the industry abuzz on the play. In that release, CHK revealed it had leased or gained commitments to lease roughly 200,000 acres in the prospective Haynesville fairway, with plans to increase this position to 500,000 over the near term. For competitive reasons, the company did not disclose the location of its acreage other than to say that it is focused more on the "eastern" portion of the play. At the time, Chesapeake had drilled seven Haynesville Shale test wells—four vertical, three horizontal—with highly encouraging results. Specifically, company management stated that its first three horizontal wells produced at rates "much better than the first three horizontal wells drilled in any other new shale play to date." The company suggested that based on early drilling results along with two years of extensive technical work, its existing leasehold could contain 7.5 Tcfe of net unrisked reserve potential, stretching to 20 Tcfe assuming its 500,000-acre target was reached. More recently, the company has increased that resource estimate to 23-44 Tcfe based on a 550,000-acre peak acreage position.

As noted earlier in this report, CEO Aubrey McClendon stated in an early-July conference call that the Haynesville Shale is likely to become America's largest natural gas field and perhaps the fourth largest in the world. The company has evidently analyzed some 70-plus well penetrations across the area in detail, and management strongly believes that the available log and other data definitively show that the shale is sufficiently thick and consistent across the play to support a wide-scale, commercial drilling effort.

CHK's ongoing willingness to pay higher and higher acreage costs to augment its already-leading position points to its high degree of conviction in the play's ultimate potential

Chesapeake's March announcement sent industry participants scrambling to quickly assess how much acreage they already had in-house, and then to formulate some form of shale strategy in very short order. A couple of producers active in the area had already drilled vertical tests through the Haynesville, and a CoreLabs group of roughly 50 companies all had access to research on the play, but by and large, no one seemed to know what they had. In our view, Chesapeake had a significant advantage based on significant investment in its Reservoir Technology Center, enabling core analysis and extensive geophysical work to be done in-house over the past two years. Only recently has CHK begun to part with sparse technical datapoints about the play; the company has reportedly choked back production on its test wells to date in order to avoid attracting undue industry attention once those flowrates hit public records. However, with Chesapeake–actions speak louder than words when in competitive leasing situations: the company's ongoing willingness to pay higher and higher acreage costs to augment its already-leading position points to its high degree of conviction in the play's ultimate potential.

The technical data we have gathered based on public disclosures to date would seem to support the very bullish early consensus that has formed with respect to the shale's prospectivity. Since the play's original unveiling, several public companies (EnCana, PennVirginia, and Petrohawk) have press-released impressive initial flowtest results from their initial horizontal drilling results, amounting to initial production (IP) rates of 8 MMcfe/d and up. Petrohawk Energy has announced the highest IP rate to date, according to publicly-disclosed results, with its 16.8 MMcf/d discovery on July 1st. Indeed, recent unconfirmed "whisper" numbers suggest these completions can offer initial production potential stretching up into the 20-30 MMcf/d realm.

Building out a preliminary type curve

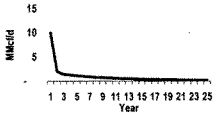
We have used various public disclosures to date to build out a representative "type curve" and, with the help of WoodMackenzie, to develop a macro production forecast for the play. Our base case type well analysis (see Figure 13) incorporates IP and EUR assumptions that appear to be near the midpoint of current industry expectations, at 10 MMcfe/d and 7 Bcfe per well, respectively. Other key assumptions include a $25,000/acre

base-case leasehold cost (this is "baked in" to the F&D shown and also incorporated within the NPV analysis as part of the well cost), 80-acre well spacing (although based on other shale plays, ultimate spacing could tighten to 40-60 acres), a $1.50/Mcfe operating cost (potentially conservative based upon recent commentary from operators), and an 80% initial-year decline rate (conservative relative to the 73% figure cited by Chesapeake in a July conference call).

Figure 13: Haynesville Shale type-curve

Inputs / assumptions			
IP		10.0	MMcf/d
1st yr decl		80%	
2nd yr decl		30%	
3rd yr decl		15%	
Terminal decl		10%	
Initial well cost	$	7.0	MM
Realized price	$	9.00	per Mcf
Operating cost	$	1.50	per Mcf
Royalty Rate		25%	
Leasehold cost		25,000	per acre
Spacing		80	acres/well
Chance of Success		100%	

Outputs (including leasehold cost)			
EUR		7.0	Bcfe
IRR		69%	
F&D cost	$	1.71	per Mcfe
NPV	$	2.01	per Mcfe

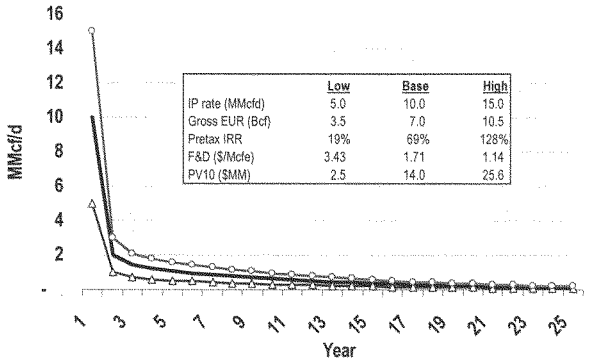


Year	Annual Decline	Daily Production Beginning	Ending	Average	Annual Production	Remaining Reserves	Cash flows CF	DCF
		---- (MMcf/d) ----			Bcf			
0							$ (9.0)	$ (9.0)
1	80%	10.00	2.00	6.00	2.190	4.81	11.5	10.5
2	30%	2.00	1.40	1.70	0.621	4.19	3.3	2.7
3	15%	1.40	1.19	1.30	0.473	3.72	2.5	1.9
4	10%	1.19	1.07	1.13	0.413	3.31	2.2	1.5
5	10%	1.07	0.96	1.02	0.371	2.94	1.9	1.2
6	10%	0.96	0.87	0.92	0.334	2.60	1.8	1.0
7	10%	0.87	0.78	0.82	0.301	2.30	1.6	0.8
8	10%	0.78	0.70	0.74	0.271	2.03	1.4	0.7
9	10%	0.70	0.63	0.67	0.244	1.79	1.3	0.5
10	10%	0.63	0.57	0.60	0.219	1.57	1.2	0.4
11	10%	0.57	0.51	0.54	0.197	1.37	1.0	0.4
12	10%	0.51	0.46	0.49	0.178	1.19	0.9	0.3
13	10%	0.46	0.41	0.44	0.160	1.03	0.8	0.2
14	10%	0.41	0.37	0.39	0.144	0.89	0.8	0.2
15	10%	0.37	0.34	0.35	0.129	0.76	0.7	0.2
16	10%	0.34	0.30	0.32	0.117	0.64	0.6	0.1
17	10%	0.30	0.27	0.29	0.105	0.54	0.6	0.1
18	10%	0.27	0.25	0.26	0.094	0.44	0.5	0.1
19	10%	0.25	0.22	0.23	0.085	0.36	0.4	0.1
20	10%	0.22	0.20	0.21	0.076	0.28	0.4	0.1
21	10%	0.20	0.18	0.19	0.069	0.21	0.4	0.0
22	10%	0.18	0.16	0.17	0.062	0.15	0.3	0.0
23	10%	0.16	0.14	0.15	0.056	0.10	0.3	0.0
24	10%	0.14	0.13	0.14	0.050	0.05	0.3	0.0
25	10%	0.13	0.12	0.12	0.045	0.00	0.2	0.0
					7.003		$ 27.8	$ 14.0

Source: Company data and Deutsche Bank estimates

In Figure 14, we illustrate alternative type-curve scenarios based on a low-case IP rate (5 MMcf/d) and a high-case IP rate (15 MMcf/d). Then, in Figure 15, we present IRR sensitivities to changes in key type curve inputs, which suggests that Haynesville Shale well economics are by far most sensitive to changes in IP rate (and hence, per-well EURs) and natural gas prices.

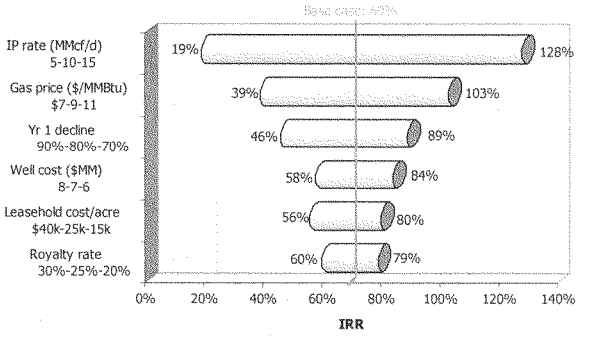
Figure 14: High and low case type curve scenarios



	Low	Base	High
IP rate (MMcfd)	5.0	10.0	15.0
Gross EUR (Bcf)	3.5	7.0	10.5
Pretax IRR	19%	69%	128%
F&D ($/Mcfe)	3.43	1.71	1.14
PV10 ($MM)	2.5	14.0	25.8

Source: Deutsche Bank estimates. Note: IRR, F&D and PV-10 figures incorporate the economic inputs and assumptions specified in Figure 13.

Figure 15: IRR sensitivity diagram to Haynesville type curve assumption changes



Bars indicate low / base / high-case pretax IRRs holding other assumptions at the midpoint.

Source: Deutsche Bank estimates

We believe Haynesville acreage values will move well higher

We expect to see additional JV and asset deals in the Haynesville, and rising per-acre transaction values

Leasehold values in the Haynesville have risen at a very rapid pace. Lease bonuses in the State of Louisiana were less than $200/acre as of early this year, but quickly jumped to the $5-10,000 realm shortly following the March play announcements from PetroHawk and Chesapeake. More recently, bids and land transactions have been risen into the $15-20,000/acre range, with a mid-June transaction between Goodrich and Chesapeake pricing out at about $17,000. Royalties have stayed steady on the whole, averaging 25% to date.

On July 2, Chesapeake and Plains E&P announced a watershed joint venture agreement under which Plains agreed to pay CHK $1.65B in cash, along with carrying CHK on $1.65B in future drilling outlays, for an effective working interest in 20% of CHK's 550,000 acres in the Haynesville. While the casual observer might conclude that play leader Chesapeake opting to monetize 110,000 net acres sends a signal that acreage prices are topping out, our analysis suggests otherwise. We believe Chesapeake's monetization was simply motivated by a pressing need for cash, and *not* a statement that $25-30,000/acre is a high water mark for leasehold values; in fact, we see ample room for rising acreage values from here.

We believe per-acre prices could push up toward the $50,000 threshold before F&D costs would push above $2/Mcfe and before IRRs would fall much below 50%

To prove the point, note that our "type curve" under base case assumptions generates a $14MM per-well net present value (incorporating an industry-standard 10% discount rate). Assuming a drilling density of 80-acres per well, this would imply an amazingly high pretax net present value of $175,000 per acre. On 60-acre spacing, that value theoretically expands to a stunning $233,000/acre. While these values are eye-popping, we note that they are pretax and impute a 100% chance of success, and few operators are likely to lease acreage without applying some sort of risk factor. As well, even though IRRs theoretically breakeven at a $175,000/acre leasehold price, most companies would find the associated F&D costs ($4/Mcfe, inclusive of the leasehold) to be unacceptable. Nevertheless, these datapoints (and the sensitivities presented in Figure 16 and Figure 17) support our contention that per-acre prices could very well push up toward the $50,000 threshold (unrisked) before F&D costs would move much above $2/Mcfe and before IRRs would fall much below 50%.

Figure 16: Pretax IRR sensitivity to natural gas pricing

Assumptions: $7MM well cost, $1.50/Mcfe op cost, 80 acre spacing, $25k/acre leasehold cost, 25% royalty

	Gas price assumption ($/MMBtu)							
IP Rate & EUR	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
5.0 / 3.5	-2%	3%	8%	13%	19%	25%	32%	39%
7.5 / 5.3	5%	13%	22%	32%	42%	54%	65%	77%
10.0 / 7.0	13%	25%	39%	54%	69%	86%	103%	120%
12.5 / 8.8	22%	39%	57%	77%	98%	120%	141%	163%
15.0 / 10.5	32%	54%	77%	103%	128%	155%	181%	208%

Source: Deutsche Bank estimates

Figure 17: Pretax IRR sensitivity to leasehold price paid

Assumptions: $7MM well cost, $1.50/Mcfe op cost, $9/Mcf gas price, 80 acre spacing, 25% royalty

	Leasehold price paid							
IP Rate & EUR	10,000	20,000	25,000	30,000	35,000	40,000	50,000	60,000
5.0 / 3.5	25%	21%	19%	17%	15%	14%	11%	9%
7.5 / 5.3	54%	46%	42%	39%	36%	33%	29%	25%
10.0 / 7.0	87%	75%	69%	65%	60%	56%	49%	44%
12.5 / 8.8	121%	106%	98%	92%	86%	81%	72%	64%
15.0 / 10.5	157%	137%	128%	121%	114%	107%	96%	86%

Source: Deutsche Bank estimates

Modeling the future production impact

We believe that by year-end 2008, the industry could have upwards of 50 new horizontal test results to evaluate, suggesting that the flow of catalysts from the Haynesville is unlikely to abate anytime soon

In addition to the 4-5 rigs currently drilling horizontal wells in the Haynesville Shale currently, we gather that no less than 30 rigs are heading to the region at this juncture, which are likely to be deployed toward initial horizontal attempts by numerous operators. We believe that by year-end 2008, the industry could have upwards of 50 new horizontal test results to evaluate, suggesting that the flow of catalysts from the Haynesville is unlikely to abate anytime soon. We likewise expect infrastructure announcements to help flesh out what type of contribution this play is likely to make to the 2009 domestic natural gas supply picture. Despite heavy (70-80%) initial-year decline rates, we suspect that production out of the Haynesville could ramp to the 500 MMcf/d level within a year's time, and will traverse the 1 and 2 Bcf/d milestone far more quickly than either the Barnett or Fayetteville Shales did before it (further discussion to follow).

Chesapeake has announced intentions to increase its operated rig count from five to 12 by end-2008. In addition to utilizing non-operated rigs throughout the play's development, the company says that it will increase its operated rig count to 30 by the end of 2009 and to 60 by the end of 2010. EnCana, through a partnership with Shell, holds the second largest announced package of Haynesville-specific acreage at 325,000 net acres. The company plans to run a five-rig program by the end of 2008. Petrohawk holds 275,000 net acres and has plans for a 10-rig program by the end of 2008.

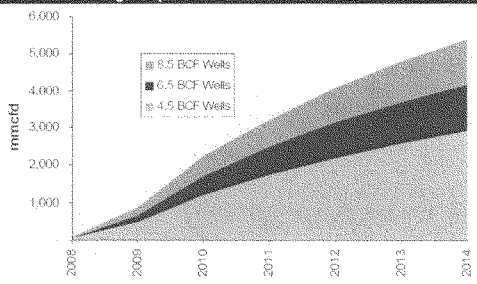
Based on the above and some detailed production modeling by Wood Mackenzie, the forecast presented below assumes that the average annual rig count in the Haynesville Shale Play will total 10 rigs in 2008, growing to 60 rigs in 2009, and ultimately 100 rigs by 2010. Petrohawk has publicly commented that the industry's rig count will grow to 100, and based on Chesapeake's rig target relative to the percentage of total acreage it operates, this target seems easily defendable. Rig capacity is a critical component to forecast total wells drilled, but Woodmac has also adjusted for operational efficiencies over time and applied what appears to be reasonable risk factors (50% and 65% for the next two years, improving over time as efficiency gains accrue). The forecast assumes an average drill time of 60 days per well in 2008, dropping to 45 days in 2010 as Chesapeake and other operators develop a better understanding of the Haynesville. Additionally, a constant tie-in cycle time of 21 days is incorporated within the model, which appears consistent with the delays some operators have experienced when bringing completed wells to sales in the Barnett Shale. Completion bottlenecks have been used to explain some operators' erratic quarter-to-quarter production jumps in the Barnett.

Three development scenarios

In terms of production rates, Chesapeake reports that its most recent eight horizontal Haynesville wells tested between 5.0 and 15.0 mmcfd, all of which were choked back. In comparison, Fayetteville and Barnett wells are not choked back, and typically flow between 2.0 and 3.5 mmcfd. As our type curve would indicate, these initial production rates tie directly to expected ultimate recovery (EUR). Published EUR figures range from 4.5 bcfe to 8.5 bcfe, and Woodmac has opted to use 6.5 Bcfe as its "base case." These are large wells relative to other shale plays, and differences in assumption around this mean will have a profound impact on the play's production profile.

The three production forecasts presented in Figure 18 show the likely volume growth assuming no constraints from infrastructure. All three suggest that the Haynesville Shale will rather quickly build to the 1 Bcf/d milestone, and ultimate production could top 5 Bcf/d.

Figure 18: Unconstrained gross production scenarios

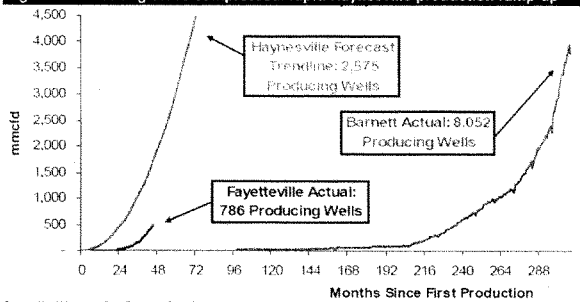


Source: WoodMackenzie

The model output is supported by some data points shared by key operators. Chesapeake recently stated that it believes the Haynesville Shale play as a whole will ultimately peak at more than 5 Bcf/d gross, which is consistent with our high-end scenario. For its part, EnCana has provided an ultimate Haynesville production target of 1.0 bcfd net. Since the company's position in the play is through a 50/50 joint venture with Shell, this would suggest that 650,000 gross acres could eventually support 2.5 bcfd of gross production, assuming a 20% royalty. Woodmac has noted that the bullish supply forecast could even prove to be conservative in the longer term. In that development scenario, total drilling over the next five years would result in less than 50% of the play being developed at 640-acre spacing, and less than 10% developed at 80-acre spacing.

These figures suggest the Haynesville may well be the country's largest gas field within five years. For perspective, over the last eight years the Barnett has grown from producing 140 mmcfd to 3.8 bcfd. Three years ago, it was producing 1.3 bcfd. The graph below showcases the development timeline of the Barnett and Fayetteville shales versus the mid-case Haynesville scenario. Best practices for acquiring acreage, modeling reservoirs, and drilling and completing shale gas wells have compressed the learning curve for all shales, meaning that operators now require much less time to commercialize high-quality plays. Further, given the Haynesville's larger per-well EURs, the play should not require thousands of successful wells to surpass production of 1.0 Bcf/d.

Figure 19: Learning curve compressed: rapid Haynesville production ramp-up



Source: Wood Mackenzie, State Production Data. Note: Haynesville Time Zero is 1Q 2008; Fayetteville Time Zero is 2004; Barnett Time Zero is 1982

The Haynesville is, in many respects, nearly ideally situated in an oil-friendly region of the U.S. with benign topography, ample access to water, oilfield services and pipeline infrastructure

Infrastructure overload?

The Haynesville is, in many respects, nearly ideally situated in an oil-friendly region of the U.S. with benign topography, ample access to water, oilfield services and pipeline infrastructure. However, we believe that infrastructure in the Haynesville area will ultimately require pipeline expansions to support the production growth we see—even the supply numbers in the low-end Haynesville case above highlights the need for new projects. New unconventional supply from the adjacent Deep Bossier and Cotton Valley plays in East Texas converge in North Louisiana. Shale gas volumes flowing east from the Barnett and Midcontinent shales move towards the Perryville Hub as well. Haynesville gas will also travel towards Perryville, but the current system can only absorb another 1.0 bcfd, according to WoodMackenzie estimates. Chesapeake Energy has stated it believes it has up to 800 MMcf/d of takeaway capacity out of the Haynesville to Carthage and Perryville before additional intrastate infrastructure is required; however, the company did note that it will be building out its own gathering lines in order to ramp up to those levels.

Pipeline operators have responded well to supply growth in the region to date, and we assume that they will do the same with the Haynesville. By all indications, planning has already begun, though development could face delays from regulators, material and skilled labor shortages, and access to capital.

Rig shortages could pose challenges for the Hayneville's development

Rig-wise, we commented earlier that we expect 100 or so rigs to be working in the Haynesville by 2010. This is based on the publicly announced plans of Chesapeake and other active operators. The Land Rig Newsletter recently suggested that work levels for 1,500 horsepower rigs are at virtually full (87%) utilization currently, and opined that a hypothetical 60-rig expansion in the Haynesville would represent a tough but likely achievable 15% expansion in this rig category within three years. If, however, our 100-rig estimate proves closer to the mark, rig shortages could pose challenges for the play's development. Chesapeake, for its part, is constructing at least two-dozen new rigs of its own, and we surmise rigs will be "cannibalized" from elsewhere in East Texas and the Barnett Shale (there are over 170 rigs active there today, albeit not all are equipped to drill deep horizontal Haynesville wells) and elsewhere, and formerly-idled rigs will likely be refurbed to the extent possible and put back into service. While visibility is far from clear at this early stage, rig availability is another potential chokepoint to be monitored.

Who wins?

PetroHawk, Goodrich, GMX Resources, Penn-Virginia and Forest Oil exhibit the highest estimated exposure to the play as a function of market cap

In Figure 20 below, we list the known publicly-traded companies involved in the Haynesville Shale play. We include active operators as well as lower-profile companies with announced or ostensible acreage positions. We have used the latest-available public data (and made a few educated guesses where precise acreage figures are not offered up by the companies themselves). Based upon the net leasehold statistics shown, we apply low, mid and high-end per-acre valuations and compare those valuations to each company's current equity market cap to glean in rough terms which stocks offer the greatest equity leverage to the Haynesville play. As Figure 21 depicts, PetroHawk, Goodrich, GMX Resources, Penn-Virginia and Forest Oil exhibit the highest estimated exposure to the play as a function of market cap. While EnCana is the second-largest Haynesville leaseholder per our estimates, its larger base of market cap dilutes somewhat its play-specific exposure on this basis.

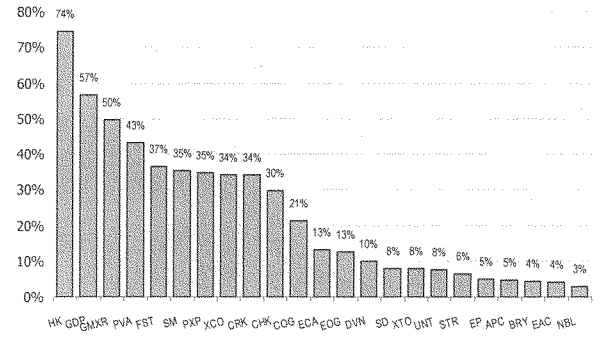
Figure 20: Active Haynesville operators and acreage positions

				7/16/2008		Potential acreage value, $MM			As % of equity mkt cap		
		Net acreage	Shares out	Price	Mkt Cap	Low	Mid	High	Low	Mid	High
Anadarko Petroleum (APC)	APC	60,000	471.5	69.12	32,590	900	1,500	2,400	3%	5%	7%
Berry Petroleum (BRY)	BRY	4,508	44.5	57.53	2,560	68	113	180	3%	4%	7%
Cabot Oil & Gas (COG)	COG	50,000	97.9	60.19	5,896	750	1,250	2,000	13%	21%	34%
Chesapeake (CHK)	CHK	440,000	583.0	63.52	37,032	6,600	11,000	17,600	18%	30%	48%
Comstock (CRK)	CRK	53,000	45.6	85.43	3,891	795	1,325	2,120	20%	34%	54%
Devon Energy (DVN)	DVN	200,000	451.2	110.34	49,788	3,000	5,000	8,000	6%	10%	16%
El Paso (EP)	EP	27,000	702.3	19.57	13,745	405	675	1,080	3%	5%	8%
EnCana Corp. (ECA)	ECA	325,000	753.0	82.95	62,461	4,875	8,125	13,000	8%	13%	21%
Encore Acquisition (EAC)	EAC	6,000	53.3	69.55	3,707	90	150	240	2%	4%	6%
EOG Resources (EOG)	EOG	150,000	249.8	118.56	29,616	2,250	3,750	6,000	8%	13%	20%
EXCO Resources (XCO)	XCO	107,000	212.0	36.91	7,825	1,605	2,675	4,280	21%	34%	55%
Forest Oil (FST)	FST	90,000	89.0	68.97	6,142	1,350	2,250	3,600	22%	37%	59%
GMX Resources (GMXR)	GMXR	27,500	16.5	84.01	1,388	413	688	1,100	30%	50%	79%
Goodrich Petroleum (GDP)	GDP	60,500	36.1	74.18	2,675	908	1,513	2,420	34%	57%	90%
Noble Energy (NBL)	NBL	18,000	175.9	89.92	15,813	270	450	720	2%	3%	5%
Penn-Virginia (PVA)	PVA	54,000	41.7	75.13	3,131	810	1,350	2,160	26%	43%	69%
PetroHawk (HK)	HK	275,000	193.0	47.9	9,245	4,125	6,875	11,000	45%	74%	119%
Plains Exploration & Production	PXP	110,000	107.5	73.35	7,885	1,650	2,750	4,400	21%	35%	56%
Questar (STR)	STR	29,500	173.3	67.54	11,704	443	738	1,180	4%	6%	10%
SandRidge (SD)	SD	32,739	166.3	61.46	10,223	491	818	1,310	5%	8%	13%
St. Mary Land & Exploration (SM	SM	50,000	61.5	57.43	3,533	750	1,250	2,000	21%	35%	57%
Unit Corp. (UNT)	UNT	11,506	47.2	79.8	3,763	173	288	460	5%	8%	12%
XTO Energy (XTO)	XTO	100,000	530.1	60.25	31,937	1,500	2,500	4,000	5%	8%	13%

Source: Company data, FactSet and Deutsche Bank estimates. Note: "Low" acreage value assumes $15,000/acre valuation; "Mid" assumes $25,000/acre, and "High" assumes $40,000/acre

While this analysis is simple and straightforward, a couple of caveats bear mentioning. First, "all acres are not created equal". The net leasehold figures in Figure 20 are stated *as reported* by the individual companies, without specificity to location in most cases. In other words, we suspect some of the acreage figures include East Texas leasehold, while others don't, and at this early stage, the play boundaries have not been established. As well, our analysis does not provide insight on how much potential Haynesville value has already been discounted in each stock; we have only issued a valuation opinion on those that are currently under coverage.

Figure 21: "Mid-case" Haynesville acreage valuation as percent of equity market cap

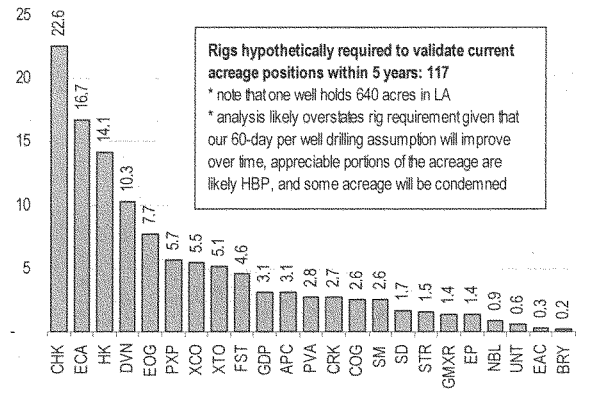


Source: Company data, FactSet and Deutsche Bank estimates

Will all this acreage be validated?...probably not

We have fielded numerous questions of late pertaining to the industry's ability to validate all these leases, given the sometimes-onerous terms attached (new leases commonly expire if production is not established within five years, and sometimes as quickly as three years plus a two-year option). We address this issue in Figure 22, which quantifies the rigs that would hypothetically be required to validate each operator's current net acreage position within five years. Here, a few points merit mention. First, we note that one well holds 640 acres in the state of Louisiana, which buys the producers a lot more time than would meet the eye assuming 80-acre ultimate development. As well, given the prevalent nature of shallow production across the region now considered prospective for the Haynesville, much of the industry's leasehold in the play is likely held by production, and thus has no "time fuse." As well, some of the leases are no doubt in areas that will prove to be less productive, and will be resold or condemned. That said, we calculate that the sector would theoretically need 117 rigs to validate every net acre currently under lease in the play, starting today. We do expect around 100 rigs to be running in the play by 2010, but quite clearly the sector will not be able to scale up to that level immediately.

Figure 22: Rigs required to validate leasehold within five years



Source: Deutsche Bank estimates

Expect ongoing M&A, JV catalysts to keep investors guessing

We believe ongoing JV announcements will be prevalent, as larger, better-funded entrants seek to consolidate positions within the play

The operators featured in the preceding analysis list all have varying financial and operating wherewithal to validate their respective Haynesville acreage positions; clearly at $6-7MM/well, the cost of drilling up a sizeable acreage position can quickly mount beyond a smaller player's ability to fund. For this reason, we believe M&A and/or ongoing joint venture announcements will be prevalent, as larger, better-funded entrants seek to consolidate positions within the play, or to initiate footholds outright.

Will the Majors finally step up?

On that note, we surmise at least a couple of large, major integrated oil companies (including Shell and ExxonMobil) have at least "starter" leasehold stakes in the Haynesville, and have likewise dabbled around in various other domestic shale plays such as the Barnett. While these sophisticated, yet large and less-nimble entities clearly have the financial and technical resources to be a dominant force in domestic shale plays, to date it has been the independents leading the way. *However, as more datapoints unfold with respect to the Haynesville in particular, the true financial requirements begin to beg questions as to whether this will finally be the catalyst to get the majors interested in scaling back up investment in the U.S. after decades of downscaling.* We noted with interest over the past week that Shell announced an all-cash offer to acquire Duvernay Oil Corp. of Canada at a significant premium to prevailing market prices, targeting that entity's commanding position in the Montney Shale play. Soon after, British Petroleum agreed to purchase Chesapeake's Woodford Shale properties for $1.75 billion, a price at the high end of expectations.

Given the size and financial requirements of developing the Haynesville, we would not be surprised to see future joint venture and/or M&A announcements involving the Majors

The Haynesville requires very deep pockets. Taking Chesapeake as an example, we note that it will require more than 5,000 wells to fully develop its 440,000-net-acre position on 80-acre spacing. Based on its planned full-scale, 60-rig program, we estimate it will require some *$35 billion* in drilling outlays over a 15-year timeframe to develop all of this leasehold, even before considering any infrastructure (or additional leasehold) expenditures. Given the steep financial requirements, but also the massive reserves potential and production ramifications, we believe a play of this scale is sufficiently large to attract the attention of a major integrated company, and would therefore not be surprised to see future joint venture and/or M&A announcements along those lines. Quite clearly, we would view this as a positive catalyst for the E&P group as a whole, and our preferred Haynesville plays more specifically.

Buy-Rated Haynesville Shale plays: CHK, FST, XCO

Among our covered companies, FST, XCO and CHK appear to offer the most attractive exposure to the Haynesville shale

Among the stocks listed in Figure 21, we currently carry Buy ratings on EXCO Resources, Forest Oil, Chesapeake Energy, Devon Energy, and XTO Energy. We also carry Hold ratings on Goodrich, EnCana, EOG Resources, SandRidge, Anadarko and Noble. Among the five Buy-rated stocks, FST, XCO and CHK appear to offer the greatest percentage exposure to the Haynesville, based on the simplistic analysis above, but more importantly appear attractively valued based on our more detailed full-company NAV models (available separately). Given our optimism surrounding the future of the Haynesville and the likely impact on the operators involved, we would seek to add to or initiate positions in these high-quality stocks at current levels. *See Figure 23 for our current E&P universe and key statistical data.*

Figure 23: Deutsche Bank E&P coverage universe

			7/16/08		Apprec	Mkt	Enterpr	EV/DACF		CFPS	
	Ticker	Rating	Price	Target	Potential	Cap $B	Val $B	08E	09E	08E	09E
Anadarko	APC	Hold	66.35	87	32%	31.0	48.8	4.9	4.2	17.15	18.48
Apache	APA	Hold	117.94	155	32%	39.5	43.1	4.3	3.4	28.47	32.37
Bill Barrett Corp.	BBG	Buy	48.63	66	36%	2.2	2.4	5.3	3.9	10.33	14.53
Chesapeake Energy	CHK	Buy	59.49	87	47%	30.8	41.0	7.2	6.0	10.16	12.82
Continental Resources	CLR	Hold	76.66	76	-1%	12.7	12.9	12.7	9.7	6.03	7.79
Delta Petroleum	DPTR	Buy	22.16	32	44%	1.4	1.8	13.3	9.1	1.84	2.92
Devon Energy	DVN	Buy	106.19	134	27%	47.8	54.6	4.4	3.3	24.90	30.40
EnCana Corp.	ECA	Hold	82.98	97	19%	63.4	72.0	6.2	5.4	15.04	11.46
EOG Resources	EOG	Hold	111.48	134	21%	27.6	28.6	5.2	4.1	21.63	26.29
Equitable Resources	EQT	Buy	62.71	87	40%	7.7	8.6	14.8	10.6	4.33	6.33
EXCO Resources	XCO	Buy	35.28	41	16%	3.7	5.8	9.6	8.4	4.30	5.26
Forest Oil	FST	Buy	66.58	90	35%	5.2	6.8	5.2	4.1	15.50	19.70
Goodrich Petroleum	GDP	Hold	69.51	74	6%	1.8	2.0	15.1	8.8	4.40	8.04
Newfield Exploration	NFX	Hold	56.93	78	37%	7.4	8.3	5.5	3.9	11.36	17.23
Noble Energy	NBL	Hold	86.09	111	30%	14.9	16.8	5.5	4.3	16.66	20.79
Pioneer Natural Res.	PXD	Buy	69.50	100	44%	8.4	10.8	6.1	3.7	13.63	21.66
Quicksilver Res.	KWK	Buy	34.80	51	47%	5.8	6.7	10.2	8.1	3.79	5.20
Range Resources	RRC	Buy	63.50	90	42%	9.5	10.6	10.2	7.4	6.41	8.93
Sand Ridge Energy	SD	Hold	59.01	69	17%	6.4	9.5	14.4	8.6	3.91	7.44
Southwestern Energy	SWN	Buy	40.85	60	47%	14.1	14.7	11.3	8.1	3.64	5.13
Ultra Petroleum	UPL	Buy	80.05	104	30%	12.7	13.0	13.6	7.9	5.94	10.00
XTO Energy	XTO	Buy	58.27	79	36%	27.9	32.7	7.2	4.8	9.45	14.44
GROUP MEDIAN					34%			7.2	5.7		

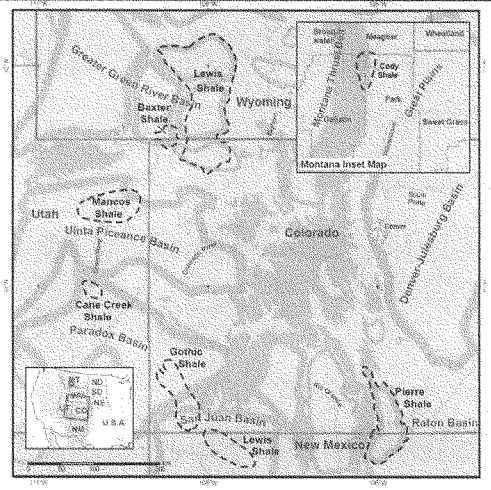
Source: FactSet, company data, Deutsche Bank estimates

What's next? Look West

Rockies shales (almost) ready for prime-time

While the Rocky Mountains region is a major producer from unconventional resource types like tight gas, coalbed methane and shale oil, shale *gas* plays have largely been untapped to date. The drilling footprint and regional impact that characterizes such plays can be problematic in environmentally-sensitive areas such as the Rockies; however, our research suggests shale gas exploration is gaining steam in this region, and we expect forthcoming announcements to highlight a number of shales that have either been overlooked or were produced with other tight gas plays.

Figure 24: Shale gas plays in the Rockies



Source: Wood Mackenzie

As indicated in Figure 24 shales are prevalent across six Rocky Mountain basins, and are in various stages of exploration. Vertical depths range from 3,000-16,000 ft and the typical play has multiple pay zones. Initial production (IP) rates are highly variable but have reached as high as 12 MMcf/d. Well costs and completion methods are still being modified as companies learn more about these emerging plays. Preliminary estimates suggest the Cane Creek and Pierre shales each hold multiple tcf of gas reserves. Others, such as the Baxter, Gothic and Cody shales, are still in the testing phase and their reserves potential are unknown. The Mancos Shale has been produced commingled with other formations and is being tested as a standalone play in the Uinta Basin by play leaders Newfield, Gasco and Questar. Companies are also exploiting the Lewis Shale as a separate play in the Greater Green River and San Juan basins.

Emerging plays

We believe six key Rockies shale gas plays (Gothic, Cody, Cane Creek, Baxter, Pierre, and Lewis) are particularly worth watching. While perhaps the most unknown of the six, the Cane Creek Shale stands out as the highest-performing play based on recent well results. The formation consists of stacked shales, interbedded with sandstones and carbonates. The total organic content of Cane Creek can be up to 28%. The formation is estimated to have resources of several Tcf. Delta Petroleum, the play's only known operator, has drilled several producing vertical wells, and is in the process of drilling horizontal completions which should improve recoveries. We expect DPTR to comment on its latest drilling results near term.

Bill Barrett is the main operator in the Gothic and Cody shales. In the Paradox Basin Gothic Shale, the company is partnered with Williams and is currently shooting 3-D seismic to identify horizontal test well locations. Another potential pay zone that lies above the Gothic Shale is the Hovenweep Shale, where BBG plans to drill a vertical test this year. In the Cody Shale, Bill Barrett and partner Devon are assessing test well results and 3-D seismic. Should the company develop the Cody Shale, it will be required to build infrastructure in the Montana Thrust Belt.

The Pierre Shale is operated by Pioneer Natural Resources, the top producer in the Raton Basin and the only company to release results from the shale to date. XTO and El Paso hold acreage adjacent to Pioneer and are assumed to be testing the shale. So far, Pioneer has drilled 10 vertical wells targeting one zone. Although this shale is still being tested, Pioneer estimates it has up to 21 tcf of gas in place. Significant upside may be realized following the drilling of horizontal wells which will test the four remaining zones in the Pierre Shale. Pioneer sees 1,200 drilling locations based on 80-acre spacing.

The Baxter Shale is an overpressured reservoir in the Vermillion Basin, which is located within the Greater Green River Basin. It has one of the largest gas in place resources of any US shale, estimated to be 440 bcf/sq. mile. However, Questar, Kodiak and its partner Devon have not been able to fully exploit the shale due to the high well cost and low IPs. We expect further drilling tests from Kodiak and Devon in the Baxter over the next 12-18 months.

The Lewis Shale, a sandy siltstone with four pay intervals, is commingled with the deeper Mesaverde and Dakota formations in the San Juan Basin and the shallower Almond formation in the Greater Green River Basin. Operators typically complete the Lewis as a secondary zone. In the San Juan Basin, the main players are ConocoPhillips, BP, Chevron and XTO. Within the Greater Green River Basin, Continental Resources, BP and Anadarko are assumed to be testing the Lewis Shale, due to their large positions in Wamsutter.

"Shale shock:" macro impact

Estimating the impact on U.S. gas supply/demand balances

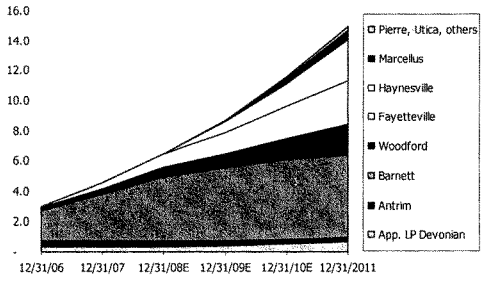
We have fielded numerous questions over the past few months relating to the impact of shale plays, and more notably the Haynesville Shale in particular, on U.S. gas supply/demand balances. Even as staunch "gas bulls" (as our research over the past 6-12 months would attest), we shudder a little each time we hear a whisper about the "latest and greatest 20+ MMcf/d Haynesville completion." While a full-blown discussion on North American and, in fact, global natural gas market dynamics is well beyond the scope of this report, we did want to at least touch on some of the moving parts that help frame the market's ability to absorb the "wall of gas" that seems to be looming in the Haynesville Shale.

In our estimation, the Haynesville presents little threat to the U.S. gas supply/demand balance until late 2009

Based on the estimates presented above, it seems likely that the Haynesville will quickly ramp up over the next 12 months to an average calendar-2009 contribution somewhere in the 0.5 Bcf/d realm. In 2010, our estimates would suggest the Haynesville will be a 1-2 Bcf/d play. In our estimation, the U.S. market can readily ingest the first 1 Bcf/d of new Haynesville supply, barring unseasonable weather this winter (or next summer). To support that, we point out that over the past six to nine months, the U.S. market has absorbed 1 Bcf/d in brand-new production from the Independence Hub project in the Gulf of Mexico, and more than 1 Bcf/d in growth from the Barnett Shale, yet gas prices rose from $7 to $12 during the first half of 2008 due to a major reduction in imported gas (both LNG supplies and piped gas from Canada) along with very robust demand (perhaps improbably, U.S. industrial sector gas consumption grew 4.8% during the first quarter of this year, despite the country's economic malaise, as chemicals and steel plants continued to run full-tilt due to fertilizer and ethanol demand, a weak U.S. dollar, and high export demand). *As a result of these forces, gas inventories are now running 389 Bcf (or roughly 1 Bcf/d) below year-ago levels, with the hurricane season and the 2008-09 winter lying ahead.*

Looking beyond the Haynesville, we have attempted to model various other growing North American shale plays and their potential contribution to the U.S. supply picture. As Figure 25 suggests, we see significant growth coming not only from the Haynesville but also the Fayetteville and Woodford shales over the next few years, with the Marcellus beginning to kick in more significantly in 2010.

Figure 25: Forecast production from major gas shale plays (Bcf/d)



Source: Company data, Wood Mackenzie, Deutsche Bank estimates

The underlying rate of decline in the U.S. production base is likely accelerating, with fast-decline unconventional plays growing in the mix

Our natural gas supply/demand model (presented in summary form in Figure 26) incorporates these projected increments, and implies a compound annual production growth rate through 2010 of roughly 5%/annum. Worth noting is that the underlying rate of decline in the U.S. production base is likely only accelerating, with fast-decline unconventional plays ever-growing in the mix. Our model assumes that more minor contributions registered in non-shale plays will largely be eaten up by natural declines in more conventional U.S. producing areas such as the Gulf of Mexico OCS.

Netting these supply contributors against expected growth in domestic gas consumption (see our recent research for further discussion on the demand side) generates a "call" on imported LNG of 2.3 Bcf/d in 2009 and 2.7 Bcf/d in 2010. This represents the quantity of gas required from outside North America to balance out supply and demand and keep storage inventories neutral. Notably, we assume a drop in piped-in gas of 1 Bcf/d each year in 2008, 2009 and 2010, which seems to be well-supported by recent trends in Mexican exports (running higher by 1 Bcf/d year-on-year) and Canadian imports (trending downward). While estimated regasification capacity will clearly more than accommodate the implied 17% growth in LNG imports (rising by 0.4 Bcf/d to 2.7 Bcf/d) we project during 2010, it's increasingly looking like those volumes could prove tough to attract. In a recent Global LNG report (see Paul Sankey's *"Sink without a Tap,"* dated 18 June 2008), the DB Integrated Oils team argues that post-2010, the US "call on LNG" will exceed available supply due to liquefaction project delays and cost overruns, as well as competition from new demand centers (countries like Kuwait, Singapore, Chile and Argentina).

Figure 26: U.S. natural gas supply/demand model

Bcf/d	2003	2004	2005	2006	2007	2008E	2009E	2010E
SUPPLY								
DOMESTIC PRODUCTION								
- Texas	16.0	16.6	16.3	17.2	18.9	20.1	21.1	21.9
- GOM			10.3	9.0	7.7	7.4	6.4	5.4
- Rockies	13.7	14.3	15.1	15.9	16.3	17.0	18.7	19.9
- All other	22.6	20.0	7.8	8.5	10.0	11.0	12.0	14.3
Total domestic production	52.3	50.9	49.5	50.6	52.8	55.5	58.2	61.4
IMPORTS (NET)								
- CANADA & MEXICO	7.7	7.7	8.3	8.1	8.4	7.4	6.4	5.4
- LNG	1.2	1.6	1.6	1.4	2.0	1.5	2.3	2.7
Total net imports	8.9	9.3	9.9	9.5	10.4	8.9	8.7	8.1
TOTAL SUPPLY	**61.3**	**60.3**	**59.4**	**60.1**	**63.2**	**64.4**	**66.9**	**69.5**
DEMAND								
- Electric generation	14.1	15.0	16.1	17.0	18.8	19.8	21.3	23.3
- Industrial	19.6	19.8	18.1	17.8	18.2	18.3	18.4	18.5
- Residential & Commercial	22.6	21.9	21.7	19.8	21.2	21.6	22.0	22.4
- Other	4.7	4.6	4.5	4.7	5.0	5.1	5.2	5.3
TOTAL DEMAND	**61.0**	**61.3**	**60.3**	**59.3**	**63.2**	**64.8**	**66.9**	**69.5**
IMPLIED NET STORAGE FILL/(DRAW)	*0.2*	*(1.1)*	*(1.0)*	*0.8*	*0.0*	*(0.4)*	-	-

Source: EIA/DOE, Wood Mackenzie, Texas Railroad Commission, Deutsche Bank estimates

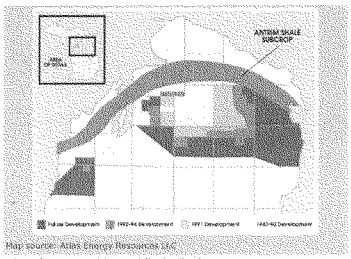
We concede visibility is not ideal out to 2010 given the uncertainties surrounding weather and the economy in the interim, and considering the real possibility that Haynesville volume growth will surprise to the upside rather than the downside. That said, our current U.S. supply/demand outlook would seem to accommodate a significant amount of new domestic production volumes without causing undue stress on natural gas pricing. We will stay attentive to the supply growth outlook and update our balances as new data merits over the upcoming quarters.

Appendix A: Shale database

Note: *All Appendix A data sourced from Wood Mackenzie, company data, USGS, and Deutsche Bank estimates. All drilling statistics pertain to horizontal wells only. Dollar figures are in US currency. Data subject to change and may not be all-inclusive.*

Established/Commercially-producing plays

Antrim Shale
Northern Michigan

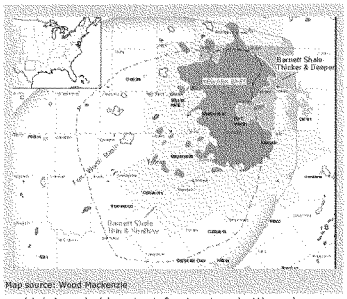


Map source: Atlas Energy Resources LLC

Key Stats:	
Depth range (ft)	600-2,200
Shale thickness (ft)	160
GIP/sq mi (Bcf)	6-15
Porosity	9%
Total organic carbon (TOC)	1-20%
Thermal maturity (Ro)	0.4-0.6%
Pressure gradient (psi/ft)	0.35
Expected Rf	20-60%
IP rates (MMcf/d)	0.04-0.3
Expected EUR per well, Bcfe	0.2-1.2
Average well cost ($MM)	$0.3-0.5
Expected F&D/Mcfe	$0.70
Typical well spacing (acres/well)	40-80
Key risks & challenges	Relatively mature shale play dominated by public MLP players

Active operators and net acreage:		
Atlas Energy Resources LLC (ATN)	53,000	Sees 760 infill locations; adding 15-20k acres/yr via leasing
BreitBurn Energy Partners (BBEP)	256,438	Purchased from Quicksilver in 2007
HighMount E&P LLC (LTR)	1,778	Purchased largely-developed position from DTE in 2007
Whiting Petroleum (WLL)	25,869	Position mostly outside operated

Barnett Shale (Core/"Tier 1" incl. Johnson Cty)
Fort Worth Basin, North Texas

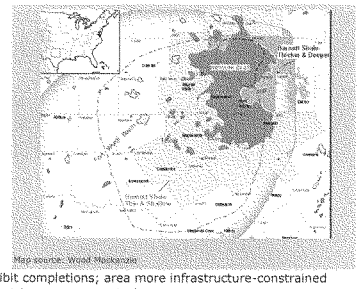


Map source: Wood Mackenzie

Key Stats:	
Depth range (ft)	6,500-9,000
Shale thickness (ft), gross	200-1,000
Shale thickness (ft), net	100-500
GIP/sq mi (Bcf)	50-200; avg 150
Porosity	4-6%
Total organic carbon (TOC)	3.5-8%
Thermal maturity (Ro)	2.2%
Silica content	40-60%
Pressure gradient (psi/ft)	0.46-0.52
Expected Rf	20-50%
Lateral lengths (ft)	2,500-3,000
Frac type	Slickwater
IP rates (MMcf/d)	2-12
Expected EUR per well, Bcfe	2-9 (Avg. 3)
Average well cost ($MM)	$2-3
Expected F&D/Mcfe	$0.80-1.30
Typical well spacing (acres/well)	25-50
Key risks & challenges	Difficult access in urban areas, high leasehold costs, infrastructure bottlenecks

Active operators and net acreage:		
Carrizo Oil & Gas (CRZO)	85,429	Sees 1.26 Tcfe of net potential assuming 65% drillable
Chesapeake (CHK)	260,000	Rig count increasing to 45 rigs
Devon Energy (DVN)	527,000	14 Tcfe risked potential; 13 yr inventory; 5-600 wells in '08
EnCana Corp. (ECA)	71,500	Assumes ~1/2 acreage in core; 1/2 noncore
EOG Resources (EOG)	96,000	200 wells, 17 rigs in 08
Quicksilver (KWK)	16,525	Includes recent acq; 460 loca's offering ~5 Bcfe each
Parallel Petroleum (PLLL)	17,600	53 gross, 20 net well program in 2008
Range Resources (RRC)	20,000	Plan 7-rig, 100-well program in 2008
Williams Cos. (WMB)	32,000	4-rig program in 2008
XTO Energy (XTO)	125,000	Running 16 rigs in core; 2,200-2,300 wells in '08

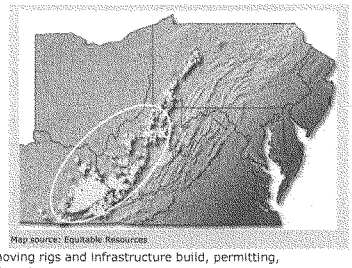
Barnett Shale (South/Western Counties)
Fort Worth Basin, North Texas



Key Stats:	
Depth range (ft)	6,500-9,000
Shale thickness (ft), net	100-250
GIP/sq mi (Bcf)	50-125
Porosity	3-4.8%
Total organic carbon (TOC)	3.5-5%
Pressure gradient (psi/ft)	0.46-0.52
Thermal maturity (Ro)	2.2%
Expected Rf	20%
Lateral lengths (ft)	2,700-2,800
Frac type	Slickwater
IP rates (MMcf/d)	1.2-4.7
Expected EUR per well, Bcfe	1-3
Average well cost ($MM)	$1.6-3.7
Expected F&D/Mcfe	$1.80-2.10
Typical well spacing (acres/well)	50-100
Key risks & challenges	Karsted areas can inhibit completions; area more infrastructure-constrained (particularly in liquids-rich western counties)

Active operators and net acreage:		
Chesapeake (CHK)	19,400	More focused in "core" area
Denbury (DNR)	40,400	45-50 well program in 2008
Devon Energy (DVN)	199,900	
EOG Resources (EOG)	554,000	150 wells in '08
EnCana Corp. (ECA)	71,500	Assumes ~1/2 acreage in core; 1/2 noncore
Forest Oil (FST)	34,000	8 wells '07; 3 rig prog '08; sees 390 Bcfe net pot.
Petroleum Development (PETD)	8,868	2 horizontals drilled to date
Quicksilver (KWK)	247,000	To drill 200+ operated wells in 2008
Range Resources (RRC)	57,000	Sees 1.4 Tcf of net potential in Hill, Ellis Cties.
XTO Energy (XTO)	125,000	3 rigs running in noncore

Devonian Shales (Huron, Cleveland, Rhinestreet)
Appalachia: KY, WV, VA

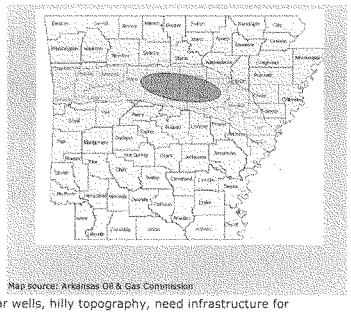


Key Stats:	
Depth range (ft)	1,600-6,000
Shale thickness (ft)	50-300
GIP/sq mi (Bcf)	5
Porosity	6-14%
Total organic carbon (TOC)	1-6.5%
Thermal maturity (Ro)	0.6-2.0%
Expected Rf	20-50%
Lateral lengths (ft)	3,500
Typical frac	Foam
IP rates (MMcf/d)	0.2-1.0
Expected EUR per well, Bcfe	1-2.2
Average well cost ($MM)	$0.5-3.0
Typical well spacing (acres/well)	80
Expected F&D/Mcfe	$1.30
Key risks & challenges	Topography complicates moving rigs and infrastructure build, permitting, severe transportation bottlenecks

Active operators and net acreage:		
Cabot Oil & Gas (COG)	962,471	Sees 3-5 Tcfe of resource potential ex-Marcellus
Chesapeake (CHK)	500,000	
CNX Gas (CXG)	193,000	Huron shale position. Sees 595-2,376 Bcfe net potential.
Dominion (D)	300,000	Retained following sale of other E&P assets to Loew's (LTR)
Equitable Resources (EQT)	2,900,000	Sees 5 potential shale opportunities; 250-300 wells in '08
EXCO Resources (XCO)	117,000	Planning 2 or more Huron tests in 2008; 1st spud Q2
GeoMet (GMET)	52,000	
NGAS Resources (NGAS)	275,000	Plans 15-20 wells in '08
Penn-Virginia (PVA)	87,500	Existing position W. VA; sees net potential of 250 Bcfe
Range Resources (RRC)	165,000	Huron Shale position; 0.8-1.5 Tcf net unrisked potential

Fayetteville Shale
Arkansas

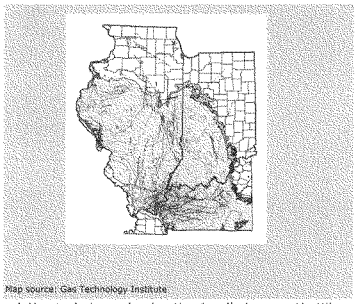
Key Stats:	
Depth range (ft)	1,500-6,500
Shale thickness (ft), gross	50-325
Shale thickness (ft), net	20-200
GIP/sq mi (Bcf)	25-65
Porosity	2-8%
Total organic carbon (TOC)	4-9.5%
Thermal maturity (Ro)	1.5-4.0%
Silica content	20-60%
Pressure gradient (psi/ft)	0.44
Expected Rf	20-40%
Lateral lengths (ft)	1,500-5,000
Frac stages	4-5
IP rates (MMcf/d)	2-4
Expected EUR per well, Bcfe	2-3
Average well cost ($MM)	$1.75-3.05
Typical well spacing (acres/well)	40-80
Expected F&D/Mcfe	$1.00-1.75
Key risks & challenges	Faulting can lead to sub-par wells, hilly topography, need infrastructure for full-scale development


Map source: Arkansas Oil & Gas Commission

Active operators and net acreage:		
Carrizo Oil & Gas (CRZO)	23,900	
Chesapeake (CHK)	585,000	Going from 11 to 25 rigs by YE.
Edge Petroleum (EPEX)	4,692	Edge is exploring merger or sale of company
Penn-Virginia (PVA)	14,500	Possibility of exit from play pending testing now underway
PetroHawk (HK)	155,000	8-rig program by YE08; 150/120 operated/non-operated wells
PetroQuest (PQ)	18,000	Five non-op rigs running
Southwestern Energy (SWN)	851,069	19-rig, 475 well horizontal program in 2008
Storm Cat Energy (SME)	18,265	400 Bcf unrisked potential; 12 well program in '08
XTO Energy (XTO)	300,000	1 rig running, 6 wells drilled in Q1-08

New Albany Shale
Illinois/Indiana

Key Stats:	
Depth range (ft)	1,000-4,500
Shale thickness (ft)	100-300
GIP/sq mi (Bcf)	8-20
Porosity	10-14%
Total organic carbon (TOC)	1-25%
Thermal maturity (Ro)	0.4-1.0%
Pressure gradient (psi/ft)	0.43
Expected Rf	10-20%
Lateral lengths (ft)	3-4,000
Frac stages	None - unstimulated
IP rates (MMcf/d)	2.0
Expected EUR per well, Bcfe	1.0-1.1
Average well cost ($MM)	$0.8-1.0
Typical well spacing (acres/well)	320
Expected F&D/Mcfe	$1.00
Key risks & challenges	Drilling, completion and stimulation techniques (and optimal well placement) still being refined; minimal commercial production to date

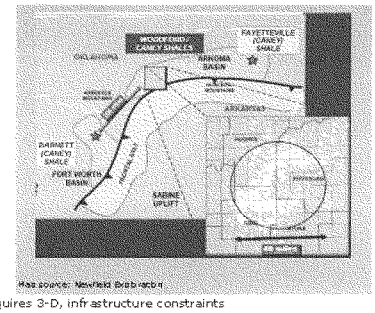

Map source: Gas Technology Institute

Active operators and net acreage:		
BreitBurn Energy Partners (BBEP)	168,430	
Carrizo Oil & Gas (CRZO)	22,000	
CNX Gas (CXG)	356,000	
Continental Resources (CLR)	44,000	
El Paso (EP)	122,000	
Forest Oil (FST)	31,900	
NGAS Resources (NGAS)	8,750	2 rigs running
Noble Energy (NBL)	179,000	15-20 well program in 2008
Rex Energy (REXX)	92,000	Partic. in 13 wells to date; 800 potential locations

Woodford Shale

Arkoma and Ardmore Basins, Oklahoma

Key Stats:	
Depth range (ft)	6,000-13,000
Shale thickness (ft), average	150 (Ark); 345 (Ard)
GIP/sq mi (Bcf)	40-120 (Ark); 220-300 (Ard)
Porosity	6-8%
Total organic carbon (TOC)	3-10%
Thermal maturity (Ro)	1.1-3.0%
Silica content	60-80% (Ark); 50-70% (Ard)
Pressure gradient (psi/ft)	0.52
Expected Rf	50%+
Lateral lengths (ft)	2,400-5,000
Frac stages	5-9
IP rates (MMcf/d)	3-12
Expected EUR per well, Bcfe	3.0-5.0
Average well cost ($MM)	$4.6-8
Typical well spacing (acres/well)	40-80
Expected F&D/Mcfe	$1.75-2.00
Key risks & challenges	Complexity & faulting requires 3-D, infrastructure constraints



Map source: Newfield Exploration

Active operators and net acreage:

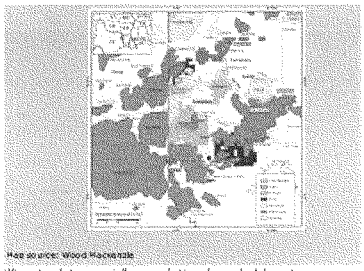
Chesapeake (CHK)	85,000	Expected 2008 divestiture
Cimarex (XEC)	25,000	Five hz wells drilled and testing
Continental Resources (CLR)	45,000	20 wells in 08, 5-6 rigs, test simul-frac
Devon Energy (DVN)	54,000	5 operated rigs running; 60 operated wells '08
Linn Energy (LINE)	46,000	Likely sale candidate given recent Marcellus disposition
Newfield Expl. (NFX)	165,000	13 operated rigs running
Penn-Virginia (PVA)	40,000	Up to 4 wells in 2008; sees net potential ~200 Bcfe
Petroquest (PQ)	39,500	20 operated wells drilled to date; 3 rigs running
Range Resources (RRC)	13,000	Sees 300 Bcf net potential
St. Mary Land & Exploration (SM)	40,000	16-well program planned for 2008; 2-3 rigs
Williams Cos. (WMB)	90,000	
Unit Corp. (UNT)	18,100	Three horizontal tests planned in 2008
XTO Energy (XTO)	160,000	6 rigs active; 8 wells drilled in Q1-08

Emerging/Developing plays: Progressing toward commerciality

Haynesville Shale (aka Bossier Shale)

Northwestern Louisiana/East Texas

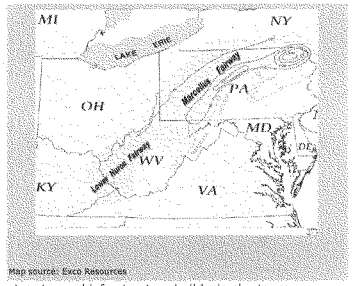
Key Stats:	
Depth range (ft)	10,500-13,500
Shale thickness (ft), net	200-240
GIP/sq mi (Bcf)	150-250
Porosity	8-12%
Total organic carbon (TOC)	3-5%
Pressure gradient (psi/ft)	0.7-0.9
Expected Rf	30%
Lateral lengths (ft)	4,000
Frac stages	5-6
IP rates (MMcf/d)	8+
Expected EUR per well, Bcfe	4.5-8.5
Average well cost ($MM)	$6-7
Typical well spacing (acres/well)	60-80
Expected F&D/Mcfe	$1.00-$1.50
Key risks & challenges	Very limited industry drilling to date; rapidly-escalating leasehold costs; undefined play extent



Key source: Wood Mackenzie

Active operators and net acreage:		
Anadarko Petroleum (APC)	60,000	
Berry Petroleum (BRY)	4,508	
Cabot Oil & Gas (COG)	50,000	DB est. Acreage position all in E TX; 1st hz 2H-08
Chesapeake (CHK)	440,000	
Comstock (CRK)	53,000	
Cubic Energy (QBIK)	6,326	4 v and 3 hz wells drilled; 10 rigs by YE-08
Devon Energy (DVN)	200,000	DB's, not company's, acreage estimate
El Paso (EP)	27,000	3 wells drilled; cites 250 additional locations
EnCana Corp. (ECA)	325,000	3 v and 2 hz wells drilled; 2 rigs running
Encore Acquisition (EAC)	6,000	
EOG Resources (EOG)	150,000	
EXCO Resources (XCO)	107,000	1st two hz test wells planned for 2H-08
Forest Oil (FST)	90,000	
GMX Resources (GMXR)	27,500	1st vert WOC; five total verts in 2008; adding leases
Goodrich Petroleum (GDP)	60,500	Company estimate; includes portion of E TX acreage
Noble Energy (NBL)	18,000	Plans one horizontal test in 2008
Penn-Virginia (PVA)	54,000	1st horizontal IP'd at 8 MMcfd; 4+ more tests in '08
PetroHawk (HK)	275,000	First hz test IP'd at 16.8 MMcf/d; 3 more drilling
Plains Exploration & Production (PXP)	110,000	Partnered with CHK
Questar (STR)	29,500	1st horiz well spudded April
SandRidge (SD)	32,739	Announced intentions to divest stake in mid-July 2008
St. Mary Land & Exploration (SM)	50,000	
Unit Corp. (UNT)	11,506	Participated in one vertical test to date
XTO Energy (XTO)	100,000	Harrison & Shelby cntys E. TX, & Bossier Parish in N. LA

Marcellus Shale
Pennsylvania

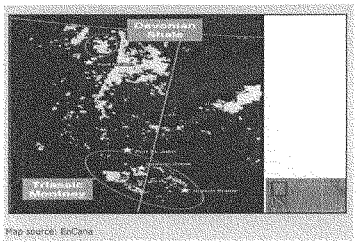


Map source: Exco Resources

Key Stats:	
Depth range (ft)	5,000-8,500
Shale thickness (ft)	50-200
GIP/sq mi (Bcf)	70-150
Porosity	6%
Total organic carbon (TOC)	2-10%
Thermal maturity (Ro)	1.0-2.5%
Silica content	40-60%
Pressure gradient (psi/ft)	0.4-0.7
Expected Rf	20-40%
Lateral lengths (ft)	2,500
Typical fracs	Slickwater
IP rates (MMcf/d)	2.6-5.8
Expected EUR per well, Bcfe	3.5
Average well cost ($MM)	$3-4
Typical well spacing (acres/well)	80-160
Expected F&D/Mcfe	$0.90-$1.60
Key risks & challenges	Topography complicates moving rigs and infrastructure build, rig shortages, severe transportation bottlenecks, permitting, fragmented land ownership

Active operators and net acreage:		
Anadarko Petroleum (APC)	275,000	
Atlas Energy Resources LLC (ATN)	483,000	
Cabot Oil & Gas (COG)	332,919	224,000 acres in SW PA "fairway" w/ 4-6 Tcfe net potential
Carrizo Oil & Gas (CRZO)	57,000	Horizontal drilling pending '08 vertical program results
Chesapeake (CHK)	1,200,000	
CNX Gas (CXG)	161,000	
Dominion (D)	800,000	Sees 515-1,964 Bcfe of net potential
Equitable Resources (EQT)	400,000	Retained following sale of other E&P assets to Loew's (LTR)
EXCO Resources (XCO)	393,000	Results pending on 1st EQT horizontal Marcellus test
Penn-Virginia (PVA)	15,000	Four hz and 7-10 vert tests planned in 08; 1st hz spud Q2
Petroleum Development (PETD)	35,000	Leasing; no drilling planned until 2009
Range Resources (RRC)	1,400,000	850,000 including highgraded acres only; 60 hz wells in '08
Rex Energy (REXX)	57,000	10-15 Tcf of net unrisked exposure; ~40 hz wells in '08
Quest Energy Partners L.P. (QELP)	119,000	
Southwestern Energy (SWN)	100,000	Testing 1st, drilling 2nd vert well. Sees 192 Bcf potential
Talisman (TLM)	640,000	Permitting for six wells in 2008
Ultra Petroleum (UPL)	140,100	Estimated PA portion of acreage.
Unit Corp. (UNT)	38,000	Announced initial acquisition in July; drilling in late '08
XTO Energy (XTO)	152,000	Recent entry: Sees 2-4 Tcfe of resource potential

Montney Shale
Fort St. John/Deep Basin Regions, British Columbia, Canada



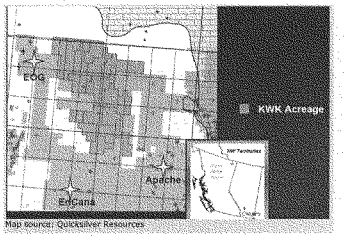
Map source: EnCana

Key Stats:	
Depth range (ft)	6,600-8,200
Shale thickness (ft)	950+
GIP/sq mi (Bcf)	75-100
Porosity	6.0%
Total organic carbon (TOC)	N/A
Thermal maturity (Ro)	N/A
Expected Rf	up to 50%
Lateral lengths (ft)	5,000
Frac stages	8-11
IP rates (MMcf/d)	5-10
Expected EUR per well, Bcfe, Bcfe	2.5
Average well cost ($MM)	$4-6
Typical well spacing (acres/well)	80-160
Expected F&D/Mcfe	$2-2.50
Key risks & challenges	Facilities bottlenecks, C$ exchange rate, winter access only

Active operators and net acreage:		
EnCana Corp. (ECA)	240,000	Drilled 13 hz wells in Q1; plans >50 hz wells in 2008
Talisman (TLM)	166,667	B.C. portion of acreage only; upside to 460,000 acres
Murphy Oil (MUR)	79,000	Sees 2 Tcf of potential; 1st production antic by end-2008

Muskwa/Ootla Devonian Shale
Horn River Basin, British Columbia, Canada

Key Stats:	
Depth range (ft)	7,800-13,300
Shale thickness (ft)	360-580
GIP/sq mi (Bcf)	180-320
Porosity	4.0%
Total organic carbon (TOC)	3.0%
Thermal maturity (Ro)	2.8%
Expected Rf	20-30%
Lateral lengths (ft)	4,600-8,200
Frac stages	6-12
IP rates (MMcf/d)	5-10
Expected EUR per well, Bcfe	4-6
Average well cost ($MM)	$7-10
Typical well spacing (acres/well)	40
Expected F&D/Mcfe	$2.00
Key risks & challenges	Remote location, infrastructure requirements, 10-12% CO_2 content, high costs, exchange rate risk, fiscal risk, Canadian basis, winter access only in certain areas

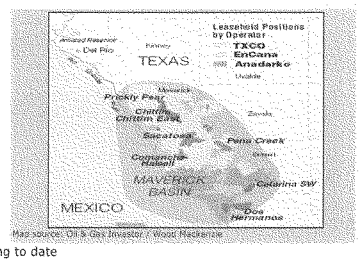


Map source: Quicksilver Resources

Active operators and net acreage:		
Apache Corp (APA)	206,638	50/50 venture w/ ECA. 9-16 Tcf of net potential.
Devon Energy (DVN)	76,000	2 hz & 1 vert to date; 2.7-5.4 Tcf net pot per Woodmac
EnCana Corp. (ECA)	220,000	In JV w/ APA. 2008 program: 7 wells
EOG Resources (EOG)	140,000	4th hz well drilling. Sees 6 Tcf of net potential.
Nexen (NXY)	123,000	Co estimates 3-6 Tcfe of recoverable contingent resources
Quicksilver (KWK)	127,000	Plans four well program during 2008-09 winter season

Pearsall & Eagleford Shales
Maverick Basin, TX

Key Stats:	
Depth range (ft)	6,000-11,500
Shale thickness (ft)	600-700
GIP/sq mi (Bcf)	100-300
Porosity	N/A
Total organic carbon (TOC)	N/A
Expected Rf	N/A
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	1.0
Expected EUR per well, Bcfe	N/A
Average well cost ($MM)	N/A
Typical well spacing (acres/well)	N/A
Expected F&D/Mcfe	N/A
Key risks & challenges	Limited industry drilling to date



Map source: Oil & Gas Investor / Wood Mackenzie

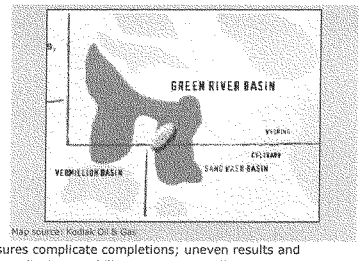
Active operators and net acreage:		
Anadarko Petroleum (APC)	349,000	Acreage will decline as TXCO & SM will drill to earn
EnCana Corp. (ECA)	130,000	3-well program in 2008, 1st completed in Q1
St. Mary Land & Exploration (SM)	75,000	Drilling to earn acreage as part of APC JV
TXCO Resources (TXCO)	683,700	2nd hz well now drilling

Exploratory plays: Initial testing underway

Baxter/Hilliard Shale

Green River and Vermillion Basins (UT/CO/WY)

Key Stats:	
Depth range (ft)	10,000-19,500
Shale thickness (ft), gross	2,850-3,300
GIP/sq mi (Bcf)	440
Porosity	3-5.5%
Total organic carbon (TOC)	1-2.5%
Expected Rf	10%
Lateral lengths (ft)	3-4,000
Frac stages	N/A
IP rates (MMcf/d)	10+
Expected EUR per well, Bcfe	20
Average well cost ($MM)	$20.0
Typical well spacing (acres/well)	40-160
Expected F&D/Mcfe	N/A
Key risks & challenges	High bottomhole pressures complicate completions; uneven results and questionable reservoir quality/permeability; environmentally sensitive region



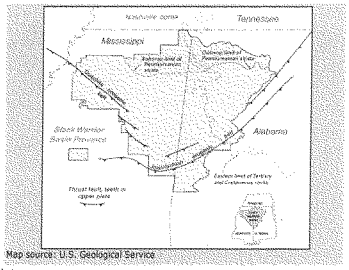
Map source: Kodiak Oil & Gas

Active operators and net acreage:		
Anadarko Petroleum (APC)	*	Unspecified but likely prospective on portions of Land Grant
Devon Energy (DVN)	157,000	AMI with KOG; 3 tests to drill by mid-2008
Kodiak Oil & Gas (KOG)	19,878	Carried 50% interest on 1st of three wells drilled by DVN
Questar (STR)	146,000	Three horizontals drilled to date; sees multi-Tcf potential
Ultra Petroleum (UPL)	62,756	Results on first deep test pending

Chattanooga Shale

Alabama/Mississippi (also TN and AR)

Key Stats:	
Depth range (ft)	1,600-4,000
Shale thickness (ft)	35-200
GIP/sq mi (Bcf)	N/A
Porosity	N/A
Total organic carbon (TOC), %	4.6%
Expected Rf	N/A
Lateral lengths (ft)	3,000
Frac stages	N/A
IP rates (MMcf/d)	0.3-.5
Expected EUR per well, Bcfe	N/A
Average well cost ($MM)	$1.1
Typical well spacing (acres/well)	N/A
Expected F&D/Mcfe	N/A
Key risks & challenges	Limited drilling success to date



Map source: U.S. Geological Service

Active operators and net acreage:		
Atlas Energy Resources LLC (ATN)	105,000	Plans a two rig horizontal shale program (4 wells/month)
CNX Gas (CXG)	132,000	3 hz wells in '09; Sees 206-825 Bcfe of net potential
GeoMet (GMET)	72,000	Plans 3 wells in 2008 including at least 1 hz in 2008

Given limited activity/testing to date, Southwestern Energy is not included in this list but has commented that most or all of its Fayetteville Shale likely prospective for the Chattanooga Shale.

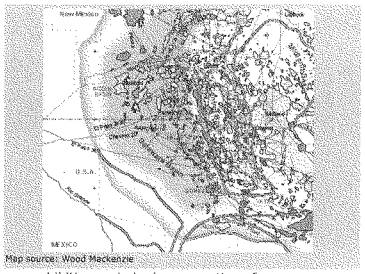
Cody Shale
Montana

Key Stats:	
Depth range (ft)	5-6,000
Shale thickness (ft)	500-1,000
GIP/sq mi (Bcf)	N/A
Porosity	N/A
Total organic carbon (TOC)	N/A
Expected Rf	N/A
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	N/A
Expected EUR per well, Bcfe	N/A
Average well cost ($MM)	$3
Typical well spacing (acres/well)	N/A
Expected F&D/Mcfe	N/A
Key risks & challenges	Nascent play concept; first drilling planned this year

Active operators and net acreage:		
Bill Barrett Corp. (BBG)	162,000	In 50/50 partnership; plans 2-4
Devon Energy (DVN)	162,000	Cody Shale tests in 2008

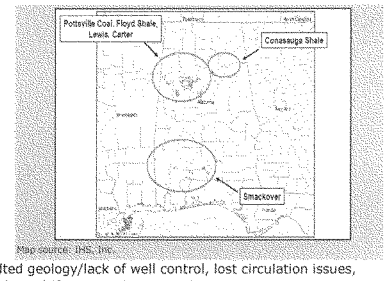
Delaware Basin Barnett/Woodford Shale
West Texas (incl. Marfa Basin)

Key Stats:	
Depth range (ft)	5,100-15,300
Shale thickness (ft)	4-800 (B); 125-350 (W)
GIP/sq mi (Bcf)	50-300
Porosity	N/A
Total organic carbon (TOC)	4-7%
Expected Rf	N/A
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	N/A
Expected EUR per well, Bcfe	3.0
Average well cost ($MM)	$6.5
Typical well spacing (acres/well)	160
Expected F&D/Mcfe	$2.50
Key risks & challenges	Clay-rich shale difficult to frac, prohibitive costs in deeper portion of basin (Reeves Cty, North of Culberson), lower TOC vs FWB Barnett



Active operators and net acreage:		
Abraxas (ABP)	15,000	
Carrizo Oil & Gas (CRZO)	70,000	
Chesapeake (CHK)	815,000	4 rigs in 2008
Continental Resources (CLR)	67,000	
EnCana Corp. (ECA)	287,000	9-well program with partner CHK underway
Quicksilver (KWK)	375,000	Sees 3-6 Tcf net potential, 1st horiz drilling
Range Resources (RRC)	20,000	1st well drilling as of late-April. Sees 400 Bcf net potential.
TXCO Resources (TXCO)	73,500	Planning 2D seismic prior to horizontal test

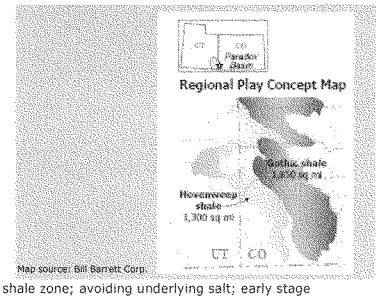
Floyd/Neal & Conasauga Shales
Alabama and Mississippi



Key Stats:	
Depth range (ft)	6,000-10,000
Shale thickness (ft)	80-180
GIP/sq mi (Bcf)	
Porosity	1.6%
Total organic carbon (TOC)	1.8%
Expected Rf	N/A
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	< 1
Expected EUR per well, Bcfe	< 1
Average well cost ($MM)	3.0
Typical well spacing (acres/well)	320
Expected F&D/Mcfe	$3.50
Key risks & challenges	Highly folded and faulted geology/lack of well control, lost circulation issues, swelling of clays, well bore drift, uncertain economics

Active operators and net acreage:		
Anadarko Petroleum (APC)	250,000	
Cabot Oil & Gas (COG)	?	644,000 gross acre position, mostly MS; 3-well '08 prog
Carrizo Oil & Gas (CRZO)	138,000	
Chesapeake (CHK)	287,500	AMI with Energen
Edge Petroleum (EPEX)	13,563	Edge is to merge with Chaparral Energy in Q4-08
Energen (EGN)	287,500	AMI with CHK
HighMount E&P LLC (LTR)	328,038	Parent Loew's purchased from Dominion in 2007
Murphy Oil (MUR)	200,000	Unconfirmed acreage position
Range Resources (RRC)	50,000	Watching industry drilling; sees 200 Bcf potential

Gothic/Hovenweep Shales
Paradox Basin, UT/CO



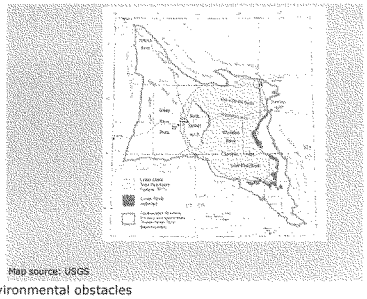
Key Stats:	
Depth range (ft)	5,500-7,500
Shale thickness (ft)	80-150
GIP/sq mi (Bcf)	N/A
Porosity	N/A
Total organic carbon (TOC)	N/A
Expected Rf	N/A
Lateral lengths (ft)	1,500-3,500
Frac stages	N/A
IP rates (MMcf/d)	N/A
Expected EUR per well, Bcfe	1-3
Average well cost ($MM)	$3.8-5.0
Typical well spacing (acres/well)	N/A
Expected F&D/Mcfe	N/A
Key risks & challenges	Containing stimulation in shale zone; avoiding underlying salt; early stage

Active operators and net acreage:		
Bill Barrett Corp. (BBG)	183,000	Shooting 3-D, 1st horizontal test planned for 2008

Lewis Shale

Eastern Green River & Washakie Basins, Wyoming

Key Stats:	
Depth range (ft)	3-6,000
Shale thickness (ft), gross	500-2,000
GIP/sq mi (Bcf)	8-90
Porosity	3-5.5%
Total organic carbon (TOC)	1-2.5%
Thermal maturity (Ro)	1.6-1.9%
Expected Rf	5-15%
Pressure gradient (psi/ft)	0.20-0.25
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	*
Expected EUR per well, Bcfe, Bcfe	.05-2.0
Average well cost ($MM)	*
Typical well spacing (acres/well)	80
Expected F&D/Mcfe	*
Key risks & challenges	Rockies permitting and environmental obstacles


Map source: USGS

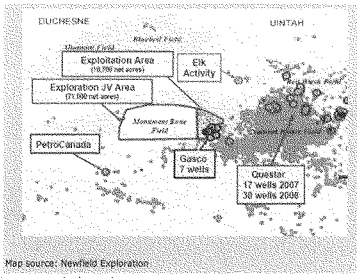
** To date the Lewis has not been targeted as a standalone play; rather contributing as a secondary zone or commingled with production from*

Active operators and net acreage:		
Continental Resources (CLR)	31,000	Five test wells drilled through 2007

Mancos Shale

Uinta Basin (CO & UT)

Key Stats:	
Depth range (ft)	13-17,500
Shale thickness (ft)	3,000
GIP/sq mi (Bcf)	280-350
Porosity	2-5%
Total organic carbon (TOC)	1.40%
Expected Rf	5-15%
Pressure gradient (psi/ft)	0.66
Lateral lengths (ft)	N/A
Frac stages	N/A
IP rates (MMcf/d)	1-2 (Mancos only)
Expected EUR per well, Bcfe	3-6*
Average well cost ($MM)	4-8
Typical well spacing (acres/well)	40-80
Expected F&D/Mcfe	$2.00
Key risks & challenges	Rockies permitting and environmental obstacles



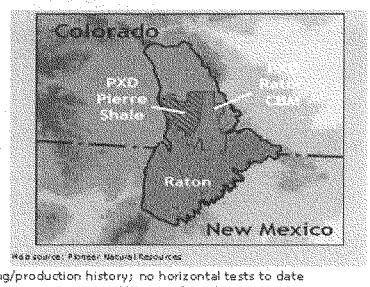
Map source: Newfield Exploration

** Note: Reflects EUR for entire section including Dakota, Mancos, Blackhawk, Mesaverde and Wasatch. Mancos standalone contribution is ~1-*

Active operators and net acreage:		
Anadarko Petroleum (APC)	225,000	Participating in "several" tests during 2008
Bill Barrett Corp. (BBG)	40,000	Plan to test Mancos via a recompletion later in 2008
EOG Resources (EOG)	70,000	Acreage not yet highgraded
Gasco Energy (GSX)	92,000	Program commenced mid-'07; 2-rig program in 2008
Newfield Expl. (NFX)	81,700	Up to 10 wells in two ventures planned for 2008
PetroCanada (PCA)	102,000	Estimated acreage figure
Questar (STR)	120,000	Plans 30 wells in 2008; 6 rig program
XTO Energy (XTO)	100,000	Not a highgraded acreage estimate

Pierre/Niobrara Shales
Raton Basin

Key Stats:		
Depth range (ft)	4,000-6,000	
Shale thickness (ft), gross	2,200-2,800	
GIP/sq mi (Bcf)	100	
Porosity	2-6%	
Total organic carbon (TOC)	1.6-2.6%	
Thermal maturity (Ro)	2.0-2.8%	
Expected Rf	16%	
Lateral lengths (ft)	N/A	
Frac stages	N/A	
IP rates (MMcf/d)	N/A	
Expected EUR per well, Bcfe	N/A	
Average well cost ($MM)	N/A	
Typical well spacing (acres/well)	80	
Expected F&D/Mcfe	$1.65-2.50	
Key risks & challenges	Limited industry drilling/production history; no horizontal tests to date Additional pipeline infrastrucure req to add material production	

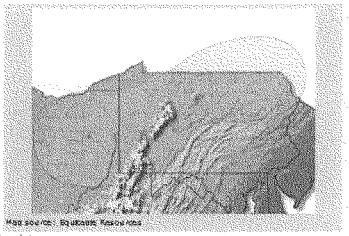


Map source: Pioneer Natural Resources

Active operators and net acreage:		
El Paso (EP)	300,000	Drilling 1st of 3 test wells planned for 2008
Pioneer Natural Resources (PXD)	134,000	2 verticals drilled, 1st hz soon; 15 wells in '08
XTO Energy (XTO)	54,317	No shale activity publicly disclosed; working CBM in area

Utica Shale (deep)
Pennsylvania/New York

Key Stats:		
Depth range (ft)	12-15,000	
Shale thickness (ft)	100-400	
GIP/sq mi (Bcf)	N/A	
Porosity	N/A	
Total organic carbon (TOC)	N/A	
Expected Rf	N/A	
Lateral lengths (ft)	N/A	
Frac stages	N/A	
IP rates (MMcf/d)	N/A	
Expected EUR per well, Bcfe	N/A	
Average well cost ($MM)	N/A	
Typical well spacing (acres/well)	N/A	
Expected F&D/Mcfe	N/A	
Key risks & challenges	No known industry drilling to date	

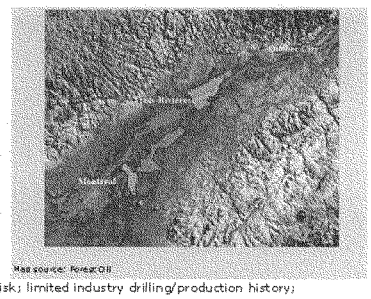

Map source: Equitable Resources

Active operators and net acreage:		
Equitable Resources (EQT)	200,000	1-2 vertical wells planned in 2008, est cost $2MM/well

Utica Shale (shallow)

St. Lawrence Lowlands, Quebec, Canada

Key Stats:		
Depth range (ft)	2,300-6,000	
Shale thickness (ft)	500	
GIP/sq mi (Bcf)	93	
Porosity	3.5%	
Total organic carbon (TOC)	1-3%	
Thermal maturity (Ro)	1.3-2.0%	
Pressure gradient (psi/ft)	0.45-0.60	
Expected Rf	20%	
Lateral lengths (ft)	2,000	
Frac stages	4	
IP rates (MMcf/d)	unknown	
Expected EUR per well, Bcfe	1.3-2.2	
Average well cost ($MM)	$2.5 - $4	
Typical well spacing (acres/well)	100	
Expected F&D/Mcfe	$2-2.10	
Key risks & challenges	Exchange rate and fiscal risk; limited industry drilling/production history; no horizontal tests to date	



Active operators and net acreage:		
Forest Oil (FST)	269,000	3 horizontals in '08; 1st prod '09; full scale dev in '10
Talisman (TLM)	760,000	

Appendix 1

Important Disclosures

Additional information available upon request

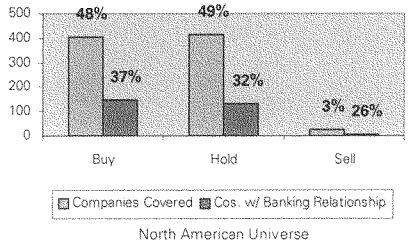
For disclosures pertaining to recommendations or estimates made on a security mentioned in this report, please see the most recently published company report or visit our global disclosure look-up page on our website at http://gm.db.com.

Analyst Certification

The views expressed in this report accurately reflect the personal views of the undersigned lead analyst about the subject issuers and the securities of those issuers. In addition, the undersigned lead analyst has not and will not receive any compensation for providing a specific recommendation or view in this report. Shannon Nome

Equity rating key	Equity rating dispersion and banking relationships

Buy: Based on a current 12- month view of total shareholder return (TSR = percentage change in share price from current price to projected target price plus projected dividend yield) , we recommend that investors buy the stock.
Sell: Based on a current 12-month view of total shareholder return, we recommend that investors sell the stock
Hold: We take a neutral view on the stock 12-months out and, based on this time horizon, do not recommend either a Buy or Sell.
Notes:
1. Newly issued research recommendations and target prices always supersede previously published research.
2. Ratings definitions prior to 27 January, 2007 were:
   Buy: Expected total return (including dividends) of 10% or more over a 12-month period
   Hold: Expected total return (including dividends) between -10% and 10% over a 12-month period
   Sell: Expected total return (including dividends) of -10% or worse over a 12-month period



North American Universe

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